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ABSTRACT

Provided in this document are 18 energy conservation activities designed to supplement regular classroom learning activities. A matrix correlating activity number with grade level and subject areas is included. Titles of activities are: puzzles; energy quiz; energy-related careers; reading a meter; trading calories for kilo-watts; conserving home energy; keep the heat; mini-activities in energy conservation; heat balance; insulation testing; conserving heat with glazing; hot water loss; calculating heat loses; conserving automotive fuel; energy in foods; conserving with the sun; comparing fuel sources; and energy in print. A teacher resource sheet is also provided at the end of each activity. These sheets contain background information, hints on gathering materials, suggested time allotment, suggested approach, typical results, precautions, modifications, evaluation methods, and references. (JN)

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ENERGY CONSERVATION EDUCATION FOR NEW YORK STATE

Hugh L. Carey
Governor

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
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Interdisciplinary
Learning
Activities
Grades 7-12

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FOREWORD

These materials were developed by classroom teachers working with staff members of the State University of New York's Atmospheric Sciences and Research Center and the State Education Department. The New York State Energy Office supported the development of these materials and provided technical review.

The activities in this manual may be considered appropriate for use by secondary school teachers as a means of supplementing regular classroom learning activities with information which will aid in reducing energy consumption.

ENERGY CONSERVATION ACTIVITIES

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ACTIVITY/GRADE LEVEL-SUBJECT AREA MATRIX

	Activity Number																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Junior High Science	x	x		x	x	x	x			x					x	x	x	x
High School Science	x	x	x		x	x				x		x	x				x	x
General Science		x		x	x		x	x			x					x		
Physical Science		x		x		x		x			x	x	x			x	x	
Physics						x			x	x	x	x	x				x	
Earth Science							x									x		
Life Science															x			
Ecology																	x	
General Math				x	x								x					
Mathematics									x							x		
Language Arts	x																	x
Social Studies			x															x
Industrial Arts							x						x					
Home Economics						x		x										
Drivers Education														x				
Multidisciplinary			x					x						x				

ACTIVITY 1

PUZZLES

INTRODUCTION

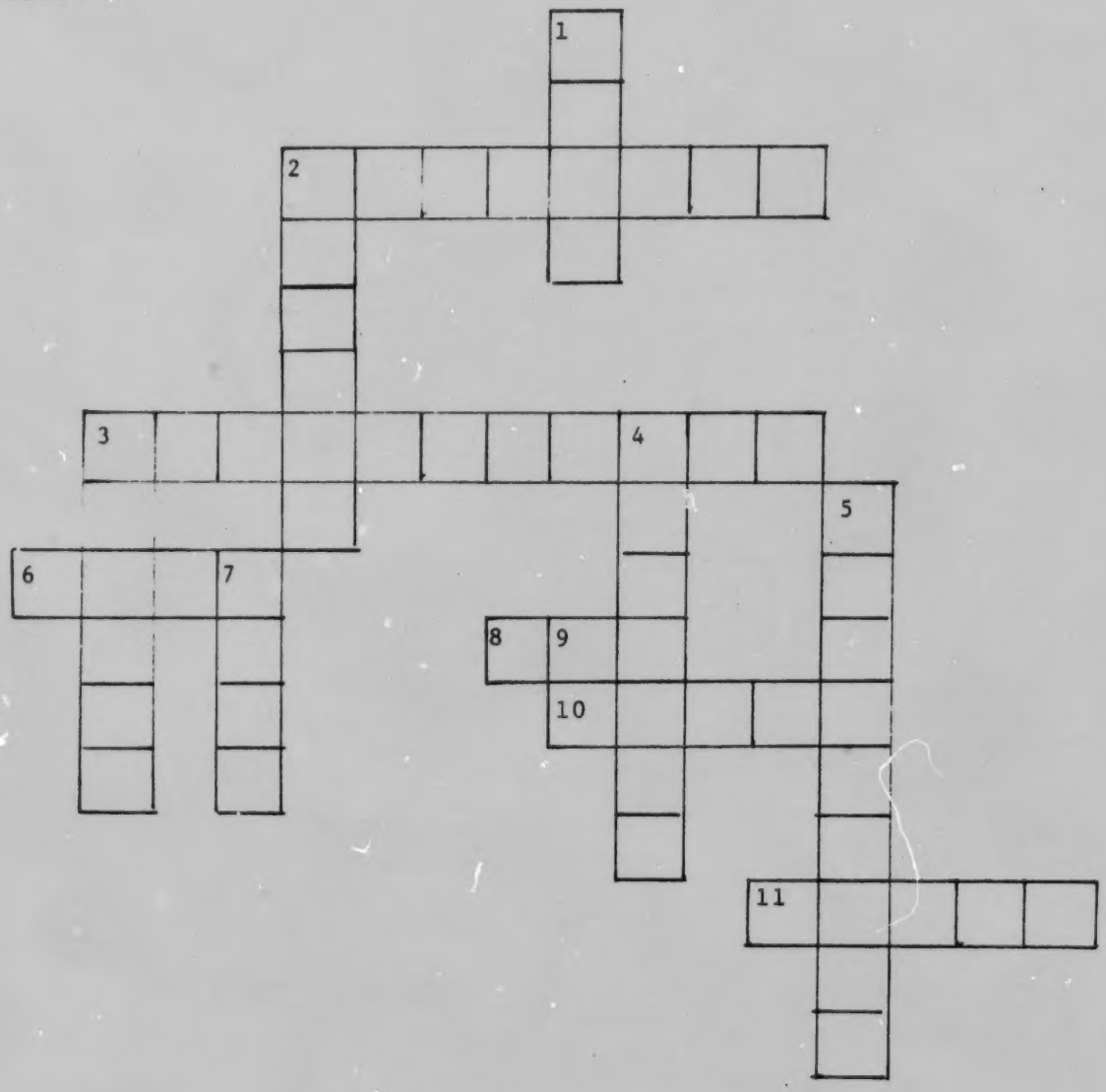
Puzzles test and strengthen your word recognition skills. The puzzles in this activity will challenge your energy vocabulary.

OBJECTIVES

At the completion of this activity you should be able to:

- use more energy terms.
- define terms found in the puzzles.
- make a list of terms that you need to define.

PUZZLE #1



ACROSS:

2 - to manage or use wisely

3 - our surroundings

6 - energy related to the average kinetic energy of molecules

8 - star which is earth's source of energy

10 - work divided by time

11 - having to do with the sun

DOWN:

1 - a substance used to produce heat

2 - a critical situation

3 - ability to do work

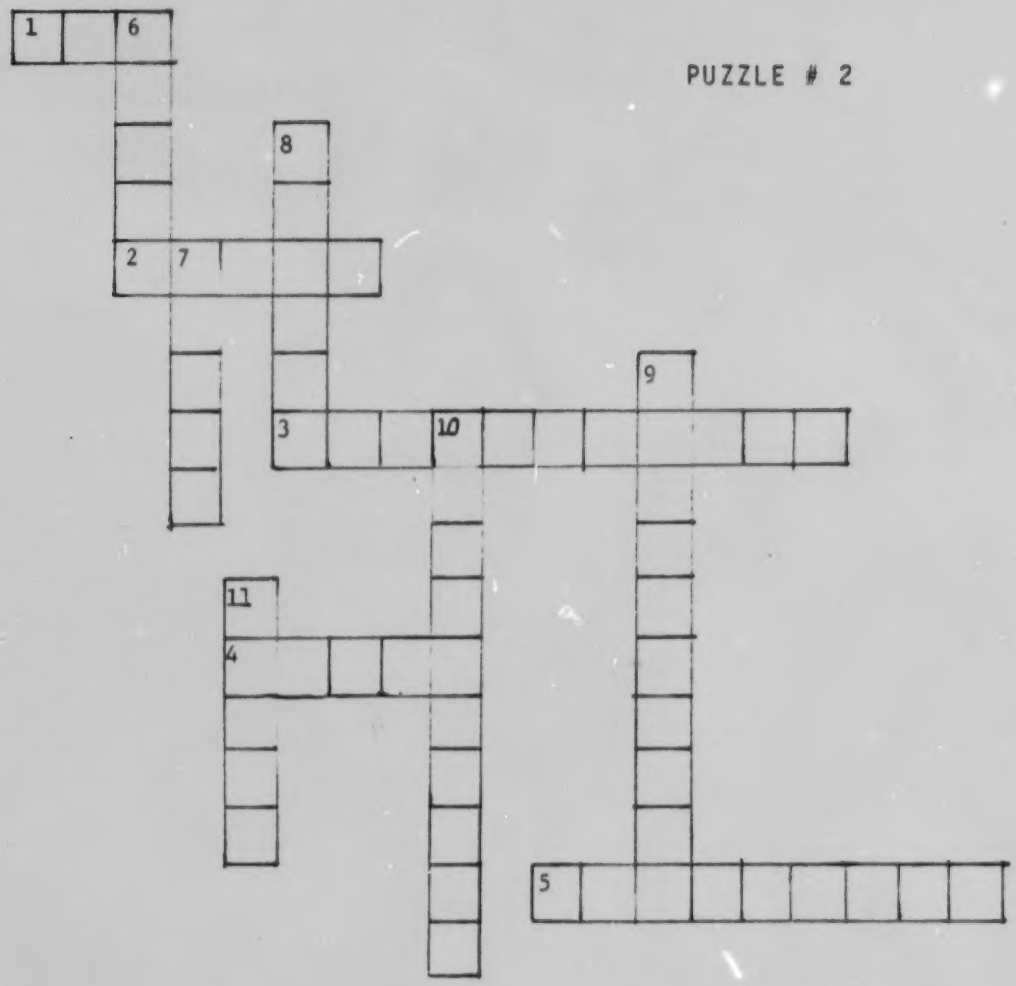
4 - management of money

5 - study of stars

7 - related to a clock

9 - opposite of down

PUZZLE # 2



ACROSS:

1 - major mode of transportation in 1970

2 - type of window that helps to keep the cold air out of the house

3 - instrument that measures the amount of heat in the air

4 - a major mode of transportation in 1870

5 - a device that absorbs energy from the sun is called a ___.

DOWN:

6 - cold air sinks. Hot air ___.

7 - if located on the west side of a building these can help to keep cold air off the outside walls of the building

8 - a very efficient way to keep heat from escaping through floors

9 - Captured heat that is produced in the interior of the earth is called ___.

10 - If 100% of light will bounce off of a mirror, this is called ____.

11 - light will bounce off of ____ surfaces better than it will bounce off dull surfaces.

PUZZLE # 3

Hidden Message:

Plus 2

Find the message by numbering the letters of the alphabet

The title of this puzzle gives a numbering clue

21 6 23 21 25 7 18 ?

18 13 2 25 23,

10 3 18 17 7 12 17 19 10 25 18 3.

Plus 4

A good poster title for community action

Hint: A = D

G R Q ' W G H O D B! F R Q V H U Y H

H Q H U J B W R G D B!

PUZZLE # 4

Word Search

Find and circle the words below in the following matrix:

L	L	W	H	E	A	T	O	R	E	D	I
F	P	I	I	N	S	U	L	A	T	E	M
C	O	N	S	E	R	V	E	D	C	R	U
O	I	D	A	R	T	U	L	I	U	A	R
U	R	S	A	G	Q	L	P	A	D	R	T
Q	U	T	S	Y	O	U	O	T	N	F	C
N	C	O	P	P	E	R	E	E	O	N	E
M	U	I	M	D	A	C	P	W	C	I	P
L	Y	K	A	E	R	B	D	N	I	W	S

HEAT
RADIATE
ENERGY
CONSERVE
COPPER
CONDUCT
GAS
WIND
PEOPLE
CADMIUM
SUN
RADIO
SPECTRUM
INFRARED
INSULATE

PUZZLE # 5

(grades 10-12)

Word Search

In the space to the right of the definition, write the word which is being defined, and then search for this word in the puzzle. Circle it.

M E C A L O R I E N I W

S A G R A M O N M E A I

M U R T C E P S I T O R

R R A L O S Y U T B S C

A B I O M A G L Y A C O

I N F I L T R A T I O N

N U A L O U E T H E A D

G S T K S U N I G P L U

D N I W S O E O I R F C

T A E H O F B N L A S T

K O T R U N C T A Q E I

M O F T L O N S T R A O

S A M N C O R A L E T N

1. A quantity of heat energy (metric). 1. _____
2. The ability to do work. 2. _____
3. The process by which heat is lost through doors and windows. 3. _____
4. A process by which energy is carried through metals. 4. _____
5. Solid form of fossil fuel. 5. _____
6. A measure of the heat content in a fuel (English system). 6. _____
7. Primary source of all forms of energy. 7. _____
8. Form in which most energy is lost. 8. _____
9. Abbreviation or unit by which electrical energy is bought and sold. 9. _____
10. All wavelengths of solar energy. 10. _____

PUZZLE # 6

Word Scramble

Unscramble the words on the right,
using the word or words on the left as a clue

1.	Ball of fire	U N S _ _ _
2.	Color me _____, I keep the heat	C L A B K _ _ _ _ _
3.	"Old Faithful" type energy	TOHLEAEMGR _ _ _ _ _ _ _ _ _ _
4.	Keeps the chicks warm (insulation)	W O N D _ _ _ _
5.	Insulate floors with a _____	P A C T E R _ _ _ _ _ _
6.	It's stuffy in here so _____	NALTIVEET _ _ _ _ _ _ _ _ _
7.	Travels like the ocean waves	T H I G L _ _ _ _ _
8.	Solar energy has an enemy	S C L U D O _ _ _ _ _ _
9.	Black gold	L I O _ _ _
10.	Conserve it !!	Y E R E N G _ _ _ _ _ _

PUZZLE # 7

Hidden Message

Choose the word that completes the blanks on the right.
The circled letters will spell out today's most
important energy theme

1. The spot at which light rays from a parabolic collector will all converge. _ _(_)_ _ _ _ _ _
2. The passage of air into a house through cracks and holes. _ _ _ _ _ _ _ _ _ _(_)_
3. The ability to do work. _(_)_ _ _ _
4. Addition of this helps seal cracks along doors and windows. _ _ _ _ _ _ _ (_)_ _ _ _ _ _ _ _
5. Wooden slats on exterior of windows. Can be closed at night to reduce heat loss. _ _ _ _ _(_)_ _
6. An expensive household fuel. _ _ _ _ _(_)_ _ _ _ _
7. Cell that converts solar energy into electrical energy. _ _ _ _ _(_)_ _ _ _ _ _
8. Solid fossil fuel. _ _(_)_
9. Energy source from below the earth's surface. _ _ _(_)_ _ _ _ _ _
10. Amount of heat required to raise 1 cubic centimeter of water one degree Celsius. _ _ _ _ _(_)_
11. Device that absorbs solar energy. _ _ _ _ _ _ _(_)_
12. Cheapest way to ship the goods (least fuel) _ _ _ _(_)

HIDDEN MESSAGE: Careful use of our energy resources:

_ _ _ _ _ _ _ _ _ _ _ _ _

PUZZLE # 8

Unscramble the underlined words
to get the entire story

Aldo and his wife, Becky, have just won the New York State lottery, and they have decided to build a new E H S O U. "Where shall we build?", asked Becky.

"How about high on a D Y N I W hill because I want to have a O M I L W I L N to generate enough T E L I C C E T R I Y to T A H E the water for our place.", said Aldo.

"That's great," said Becky, "but don't forget if we build there, the house will have to have lots of A L T I N N U S I O. I don't want to be cold."

"Where shall we put that material you spoke about? In the E S T B A N E M , the S L W A L , or the T A T C I?"

"All those places, of course. Don't forget we will need R M O S T O N D I W W S, and most of these should be on the O H U S T wall."

"I think we should have large pine trees on the west side to act as a D A K E R B I N W."

"Guess we should have a T H E A M U P P also. I hope we get an architect who knows what we want and can really deliver nice plans."

"Oh, Aldo, you're so wonderful. By the way, who gave you the money to buy the lottery ticket?"

Teacher Information Sheet

PUZZLES

Suggested Grade Level and Discipline

7-12 All Sciences

Background Information

Puzzles and games often provide a welcome relief from the concentration required by more comprehensive activities. Yet they also can provide opportunities for reviewing terms and concepts in new and provocative ways. Possible applications to energy conservation are numerous.

Crossword Puzzles

Still to be considered worthwhile are the traditional crossword puzzles using clues that are related to energy conservation. Some people are extremely talented in the creation of such word patterns. There are many simple patterns that can be varied and re-invented by the students.

Word Searches

Students enjoy finding words related to energy conservation hidden in a matrix of letters. Depending upon the difficulty of the vocabulary involved, the words may be provided with definitions or they may be left for the students to discover directly themselves.

Word Scrambles

Unscrambling words which become energy-related terms can be challenging to students, especially when tied to other tasks as indicated in this activity.

Hidden Message

Word completion exercises that would otherwise be fairly routine can become more intriguing when they are designed as indicated in the example.

Hints on Gathering Materials

- Begin and maintain an energy puzzle file. Invite student submissions.

Suggested Approach

- Use these activities to change the pace of classwork or to introduce/review energy topics.

ANSWERS - PUZZLES

PUZZLE #1:

Across:
2. conserve
3. environment
6. heat
8. sun
10. power
11. solar

Down:
1. fuel
2. crisis
3. energy
4. economy
5. astronomy
7. time
9. up

PUZZLE #2:

Across:
1. car
2. storm
3. thermometer
4. horse
5. collector

Down:
6. rises
7. trees
8. carpet
9. geothermal
10. reflection
11. shiny

PUZZLE #3:

Plus 2: Why Wait? Today, Let's Insulate.

Plus 4: Don't Delay! Conserve Energy Today!

PUZZLE #4:

L L W H E A T O R E D I
F P I I N S U L A T E M
C O N S E R V E D C R U
O I D A R T U L I U A R
U R S A G Q L P A D R T
Q U T S Y O U O T N F C
N C O P P E R E E O N E
M U I M D A C P W C I P
L Y K A E R B D N I W S

PUZZLE #5:

M E C A L O R I E N I W
S A G R A M O N M E A I
M U R T C E P S I T O R
R R A L O S Y U T B S C
A B I O M A G L Y A C O
I N F I L T R A T I O N
N U A L O U E T H E A D
G S T K S U N I G P L U
D N I W S O E O I R F C
T A E H O F B N L A S T
K O T R U N C T A Q E I
M O F T L O N S T R A O
S A M N C O R A L E T N

1. calorie
2. energy
3. infiltration
4. conduction
5. coal
6. BTU
7. sun
8. heat
9. KWH
10. spectrum

PUZZLE #6:

1. sun
2. black
3. geothermal
4. down
5. carpet
6. ventilate
7. light
8. clouds
9. oil
10. energy

PUZZLE #7:

1. focal point
2. infiltration
3. energy
4. weather-stripping
5. shutters
6. electricity
7. photovoltaic
8. coal
9. geothermal
10. calorie
11. collector
12. train

HIDDEN MESSAGE: CONSERVATION

PUZZLE #8:

1. house
2. windy
3. windmill
4. electricity
5. heat
6. insulation
7. basement
8. walls
9. attic
10. storm
11. windows
12. south
13. windbreak
14. heat
15. pump

ACTIVITY 2

ENERGY QUIZ

INTRODUCTION

How much do you know about energy? Your personal decisions will affect consumption of resources, conservation practices, the attitudes of friends, and legislation for the foreseeable future. How informed will your decisions be?

This is an energy survey that should take from twenty to thirty minutes to complete. The test of forty questions evaluates your knowledge of various facts that are useful in making decisions about energy conservation. An answer key is supplied.

OBJECTIVES

At the completion of this activity you should be able to:

- o identify energy information with which you are familiar.
- o identify energy topics where you need more information.

SKILLS AND KNOWLEDGE YOU NEED

- How to take a standard multiple-choice test.

MATERIALS

- Pencil and paper.

METHOD

1. On a piece of notebook paper, number from 1 to 40. Before you start the test, make sure that you understand the scoring rules: correct response = 2.5 points; no response = 0 points; and incorrect response = -1.

   The penalty for guessing makes sense if you realize that there are many people who give incorrect information when influencing the decisions of others. If you are not sure of your information, you should double-check your facts, not guess.

2. Using the key, score your paper in the following way:

Number of correct responses	x 2.5 =	_____
Number of no responses	x 0 =	_____
Number of incorrect responses	x -1 =	_____
	TOTAL	_____ points

3. Re-check your test and locate the incorrect responses. Circle the correct answer for each and discuss the correct answer with others for better understanding.

LOOKING BACK

Depending on your score on this test, you may feel satisfied or dissatisfied about your knowledge of energy.

QUESTIONS

1. What are the topics that you least understand?

2. What topics were least understood by large numbers of students in the class?

3. With what areas of energy are you most familiar?

GOING FURTHER

- Find material on the topics that are least understood. Many of these facts are not new and can be found in standard reference books in the library.

- Update your information. Find the number of the "hot line" for your state energy office and check facts not available in the library.

- Using the reference materials you find, design your own multiple-choice test and try it out with your classmates.

ENERGY QUIZ

Multiple Choice Questions

1. Types of energy are:

   a) heat
   b) light
   c) motion
   d) all of the above

2. Which of the following is not considered to be a fossil fuel?

   a) natural gas
   b) coal
   c) oil
   d) geothermal

3. The term oil is the common name for:

   a) natural gas
   b) petroleum
   c) lignite
   d) carbon

4. The two major substances which make up petroleum are:

   a) lignite and water
   b) carbon and sulfur
   c) hydrogen and oxygen
   d) hydrogen and carbon

5. The most economical method of transporting oil is by:

   a) pipelines
   b) ships
   c) trucks
   d) railway tankers

6. The group of crude oil products made from crude oil by a variety of chemical reactions is called:

   a) synthetic crude oils
   b) petrochemicals
   c) kerosenes
   d) gasification

7. Which of the following is not an end product of crude oil?

   a) orlon
   b) plastics
   c) silk
   d) road pavement

8. Oil supplies how much of the total energy needs of the United States?

   a) 0 - 25 percent
   b) 25 - 50 percent
   c) 50 - 75 percent
   d) 75 - 100 percent

9. What percent of the oil used in the United States is imported?

   a) 0 - 25 percent
   b) 25 - 50 percent
   c) 50 - 75 percent
   d) 75 - 100 percent

10. To restore land that has been strip mined, the correct steps are:

a) replaced overburden, levelled overburden, regrowth of overburden
b) levelled overburden, regrowth of overburden, rotation
c) exploration, transportation and marketing
d) overburden, mine, run-of-mine

11. Restoring the land to use after mining is called:

a) strip mining
b) regrowth
c) exploration
d) reclamation

12. Which of the following is <u>not</u> a by-product of coal?

a) nylon
b) perfume
c) plastic
d) oxygen

13. Coal is baked in large ovens to drive off gases to produce:

a) bituminous coal
b) coal oil
c) coke
d) pig iron

14. The class of coal which gives off heat the longest when burned is:

a) peat
b) bituminous
c) anthracite
d) lignite

15. Bituminous coal is usually:

a) found near the surface
b) found deep in the earth
c) found exposed at the surface
d) not found in the earth's crust

16. Coal is usually surface mined where:

a) coal is found deep in the earth's crust
b) coal has no overburden
c) coal is found close to the surface
d) coal can be easily transported to market

17. In a nuclear reaction, the part of the atom that splits is called the:

a) neutron
b) proton
c) electron
d) nucleus

18. The main difference between a coal-fired power plant and a nuclear power plant is:

a) the turbine used in nuclear plants is radioactive
b) the generators in coal-fired plants are larger than those used in nuclear plants
c) the fuels used are different
d) coal-fired plants waste more heat

19. Geothermal energy comes from:

a) the thin crust of the earth
b) magma
c) the earth's interior of molten rock
d) both b and c

20. The main drawback of geothermal energy is:

a) it must be close to the area it will serve
b) it creates more environmental problems than fossil or nuclear fuels
c) geothermal wells are extremely noisy
d) both a and c

21. The sun will probably continue to produce energy for a period of:

a) 5 thousand years
b) 5 hundred thousand years
c) 5 million years
d) 5 billion years

22. To change sunlight directly into electricity we could use:

a) silicon cells
b) storage batteries
c) solar panels
d) focusing collectors

23. Which of the following is <u>not</u> generally used for solar heat storage:

a) rock
b) water
c) plastic
d) concrete

24. Manure yields which one of the following fuels?

a) kerosene
b) nuclear
c) methane
d) gasoline

25. Bioconversion is a term which refers to:

a) the changing of plant and animal matter into oil over long periods of time
b) the changing of lignite to synthetic crude oil
c) the changing of one form of energy into another by plants
d) both a and b

26. Windmills were first used in the country we call:

a) Holland
b) China
c) Iran
d) England

27. The minimum wind speed required for using a windmill is about:

a) 40 km/hr
b) 30 km/hr
c) 20 km/hr
d) 10 km/hr

28. Which of the following would be a good location for siting a windmill?

a) near the top of a hill
b) on an open plain
c) in a narrow valley
d) all of the above

29. Hydropower is considered a renewable energy source because:

a) dams are easy to make with our technology
b) water can be stored in reservoirs
c) the greater the head of water, the greater its power
d) the sun supplies the energy to replace the water in reservoirs

30. Which of the following supplies the least amount of electricity in the United States?

a) oil and coal burning plants
b) hydropower plants
c) geothermal plants
d) nuclear power plants

31. The power company measures the energy we have used in units called:

a) volts
b) kilowatt hours
c) kilowatts
d) BTU's

32. The lead time for a power station refers to:

a) the amount of time a station has been operating
b) the time allowed for a plant to prove itself
c) the time needed for government approval, planning, and building a plant
d) only the time needed to get government approval for a plant

33. Which of the following conserves the least energy?

a) taking the bus to school
b) driving an automobile to school
c) walking to school
d) riding a bicycle to school

34. The first sign that gasoline was becoming scarce was:

a) smaller cars
b) fewer cars
c) more cars
d) higher prices for gasoline

35. Energy conversion means:

a) changing energy from one form to another form
b) creating a new form of energy
c) storing up energy in a particular form
d) using energy in machines

36. When turbines turn electrical generators:

a) mechanical energy is converted to electrical energy
b) heat energy is converted to mechanical energy
c) heat energy is converted to electrical energy
d) electrical energy is converted to mechanical energy

37. Society's demand for energy is:

a) increasing
b) decreasing
c) remaining the same
d) less than it was 10 years ago

38. To make sure that our energy resources will last, we must:

a) realize that we have developed wasteful attitudes towards energy
b) realize that what seems like an inexhaustible supply will quickly be consumed by a steady increase in demand
c) conserve energy
d) all of the above

39. Citizens have different attitudes towards conservation because:

a) different people believe different things
b) people are given misleading information
c) people have been brought up with different attitudes
d) all of the above

40. A trade-off happens when:

a) you fail to make a good "deal"
b) you sacrifice one thing for something else
c) you keep your luxuries and use more energy
d) all of the above

ANSWER KEY FOR ENERGY QUIZ

1.	d	21.	d
2.	d	22.	a
3.	b	23.	c
4.	d	24.	c
5.	a	25.	c
6.	b	26.	c
7.	c	27.	d
8.	b	28.	d
9.	b	29.	d
10.	a	30.	c
11.	d	31.	b
12.	d	32.	c
13.	c	33.	b
14.	c	34.	d
15.	a	35.	a
16.	c	36.	a
17.	d	37.	a
18.	c	38.	d
19.	d	39.	d
20.	d	40.	b

Teacher Information Sheet

ENERGY QUIZ

Suggested Grade Level and Discipline

7-12 Science

Background Information

This is not a norm-referenced test and has not been designed to serve as an achievement examination. The survey test should be used as a motivational tool to encourage students to increase their knowledge in order to make better decisions.

Suggested Time Allotment

- A single class period should be sufficient for administration and scoring. Questions can be answered at home.
- An extra period of library research time is suggested for investigating new knowledge.

Suggested Approach

- Administer the test and allow for student scoring.
- Perform an item analysis for planning group or class work on poorly understood topics. An item analysis can be done easily by recording a "show of hands" survey item by item. Those items that were not answered or answered incorrectly by large numbers point out topics that should be developed further.

Typical Results

- Student scores on the quiz will vary widely depending upon grade level and prior experiences in energy education. Expect a large range in scores within and between your science classes.

Precautions

- *You may wish to remove the answer key from the student sheets if this represents too great a temptation for some youngsters. Then provide the key to students following test completion.*
- *Emphasize that scores on the quiz will not be recorded for the purpose of assigning grades.*

Modifications

- Subsequent to the item analysis, groups of students might be asked to investigate different topics not well understood by the class. Group reports back to the class might follow.

- Students often enjoy preparing their own objective tests. Different groups might develop test items on various energy topics and provide these questions to a student committee charged with the final test construction. The prepared test could then be administered to the entire class or different classes within the school, or printed in the school newspaper.

Evaluations

- Note student scores by moving around the classroom as they evaluate their quizzes.

- Item difficulty will be ascertained through a "show of hands" item analysis.

References

Those facts not provided by an encyclopedia may relate to specific fields of energy. Students could write letters asking for material. Current information will be available from:

- American Gas Association, Educational Services, 1515 Wilson Blvd, Arlington, Virginia 22209

- American Petroleum Institute, 1801 K Street, NW, Washington, D.C. 20005

- American Wind Energy Association, 21243 Grade River Street, Detroit, Michigan 48219

- Atomic Industrial Forum, Inc., 7101 Wisconsin Avenue, Washington, D.C. 20014

- Edison Electric Institute, Educational Services, 90 Park Avenue, New York, New York 10016

- National Coal Association, Education Division, 1130 17th Street, NW, Washington, D.C. 20036

- Solar Energy Industries Association, Suite 632, 1001 Connecticut Avenue, NW, Washington, D.C. 20036

ACTIVITY 3

ENERGY RELATED CAREERS

INTRODUCTION

Energy conservation will become increasingly important as people become more aware of the consequences of waste. Prices of fossil fuels are increasing and will continue to increase. The costs of waste alone will convince many of the need for better energy management.

Research into and development of the technological applications of solar, wind, and biomass energies will require new skills and create new careers. The problems of correcting old mistakes in existing buildings have already created career opportunities for people in many occupations.

In this activity you will investigate energy vocations, to find out what is happening to them, how, and what is predicted to happen in the immediate and more distant future. You will have an opportunity to consider your future in the light of what is being presently accomplished in the world of work and what will be happening when you make critical decisions about your future.

OBJECTIVES

At the completion of this activity you should be able to:

- o list careers in the energy field that currently exist.
- o discuss the skills and training required for those careers of possible interest to you.
- o locate the best sources of information related to energy careers.
- o predict careers that will become increasingly important and require skilled people.

SKILLS AND KNOWLEDGE YOU NEED

- Library research skills in using the Reader's Guide to Periodical Literature and career education files available in your school.

MATERIALS

- A folder for the collection of information related to energy careers.
- Current classified advertisement sections from several newspapers.
- "Help Wanted" and "Careers" sections of a newspaper with a large circulation.
- File cards for recording, copying, and organizing information.

METHOD

1. Investigate the career guidance files in your school for careers related to energy. Record each career opportunity and the required skills for that career on a file card.
2. Search the college catalogues in your school file for training and degree programs related to technical and engineering careers. Record on a file card the career opportunities and the high school prerequisites required for admission to each program. Record the names of schools providing necessary training on the cards completed in step 1.

3. Review the classified sections of large circulation newspapers for energy-related job advertisements. Some newspapers will be available in the school library. Record the information on file cards. In certain cases, it will be possible to copy the advertisement.

4. Repeat the above with trade journals or scientific magazines.

5. Write a business letter to one of the organizations listed in the classified advertisement sections requesting information about a career and employment as a possible future member of the organization.

6. Interview a person in one of the occupations listed in the classified advertisement sections. In such an interview you might ask questions such as the following:

   What are the most important skills a person can bring to this kind of occupation?

   What training will be required to be successful?

   What are the greatest problems that people face in this profession?

   What are the major professional satisfactions of this occupation?

LOOKING BACK

If your research and that of others working on the same topic has been thorough, you should have discovered that a large number of occupations require energy-related skills and knowledge. Businesses of many sizes, industrial organizations, government agencies and non-profit associations all have energy concerns.

QUESTIONS

1. What are some of the new career opportunities in energy-related vocations?

2. What energy-related occupations are available to people?

   a. completing high school?
   b. with two years or less of post high school training?
   c. with four years of post high school training/ education?
   d. with five or more years of post high school training/ education?

3. Where should one look for the fastest-growing job opportunity related to energy?

4. From the information you have gathered in this activity predict which careers you feel will become increasingly important in the future. Why did you predict these particular careers?

LOOKING BACK

- Create an energy career display for others who might be interested in energy-related occupations. Include photos, pictures and illustrations, as well as data on career opportunities that require various amounts of training. Also provide information, for those who want to find out more, suggesting where they should look.

- Invite several individuals engaged in energy-related occupations to give guest presentations to your class. Each might indicate necessary skills and training, the daily requirements of the job, and interesting personal experiences.

Teacher Information Sheet

ENERGY RELATED CAREERS

Suggested Grade Level and Discipline

9-12 Science
Interdisciplinary

Background Information

Energy-related careers cut across all of the traditional vocational areas. Physicists, chemists, and geologists will be needed in increasing supply as basic research into alternative energy sources and higher fossil fuel retrieval techniques expands. Technological development to meet higher demands for energy will involve the efforts of those in many engineering fields. There will also arise the need for a host of analysts to interpret for business and government the economic and social impact of altering energy sources and uses. The role of educators in supporting the development of an "energy literate" population is quite apparent. Builders and designers who are trained to be aware of energy considerations will also be important.

It is imperative that the labor force of tomorrow become aware of career options in energy prior to post-secondary training. This activity is an attempt to meet this objective.

Hints on Gathering Materials

- Pre-plan this activity with the pupil personnel services staff (guidance) and the school library. Consider timing the activity so it will relate to other career functions planned by the school.
- Build on the resources currently available in the school such as career guidance files, computerized information systems, and counselling services already in place.
- Consider how student work might be shared with other classes through the ongoing career education program in the school. Information collected by some students may be of use to others after the activity has been completed.

Suggested Time Allotment

- The work can generally be completed outside of class over several weeks. Schedule class-time discussion and informational sharing.

Suggested Approach

- Begin the activity with a discussion of energy concerns and what students feel should be done. Have a classified section of a large newspaper available as well as news stories and magazine articles that refer to occupations obviously related to energy work. These articles may be useful in starting or expanding the discussion.

- Don't define energy careers too narrowly for the purposes of this activity. A student who has no particular interest in engineering or technology could investigate energy careers in public relations, education, film-making, government service, etc.

Precautions

- *Students should be reminded to display courtesy and tact when corresponding with or interviewing individuals in energy-related fields.*

Evaluation

- Collect students' folders and examine file cards, information collected, and interview notes.

- You might request that students keep a log of their energy career activities.

- Check students' answers to the questions.

References

Careers in Energy Industries, Federal Energy Administration, Washington, DC 20461

ACTIVITY 4

READING A METER

INTRODUCTION

To combat the energy crisis, we must realize that we can live comfortably while using less energy. We are often wasteful in our use of electricity and the non-renewable resources which produce electricity. It is time to look at our electrical needs and to attempt an individual "kilowatt cutback." Even though one person's contribution may seem small, the combined efforts of many individuals can greatly reduce total electrical usage. Each person's acts of conserving energy in the home can have an impact on the family, the community, the nation, and the entire world.

OBJECTIVES

At the completion of this activity you should be able to:

- o read an electric meter.
- o calculate the cost of electrical energy used in your home.
- o determine what energy conservation efforts are effective in your home.
- o determine the exact amount of energy saved by your energy conservation practices.

SKILLS AND KNOWLEDGE YOU NEED

- Understanding the meaning or value of a kilowatt-hour.

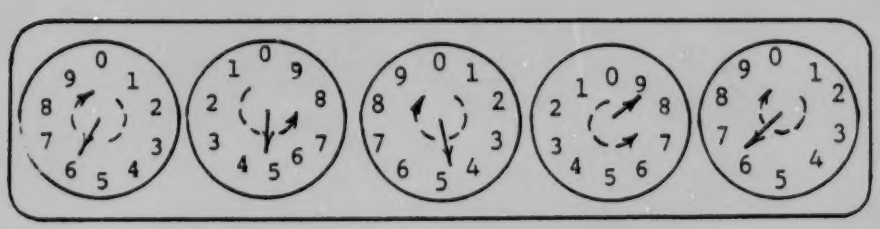
MATERIALS

- An electric meter in operation.

METHOD

1. The amount of electricity you use is measured in kilowatt-hours. It is measured by a meter located outside your home. Most standard electrical meters are circular or rectangular units, containing four or five dials. Some are different, however (for example, digital meters).

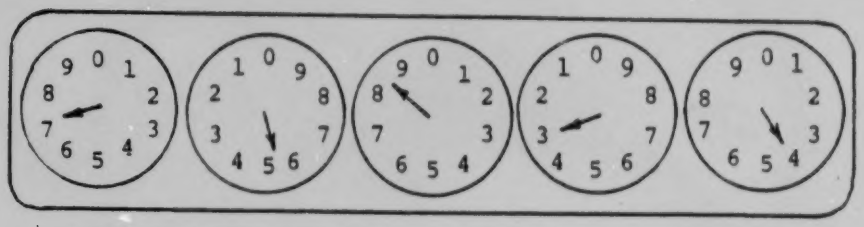
   Each dial in the meter rotates in the opposite direction from the dial next to it. You should start your reading with the dial that gives the smallest unit (kwh). (See illustration below.)



10,000's 1,000's 100's 10's 1's

2. To read the meter, you read the dials from right to left and record the numbers in the same order. When the indicator lies between two numbers, record the smaller number. (Exception: when the indicator lies between 9 and 0, record 9.) See the sample reading below.

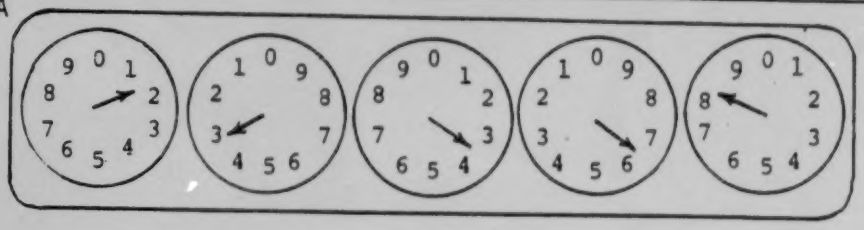
SAMPLE:



READING 75834

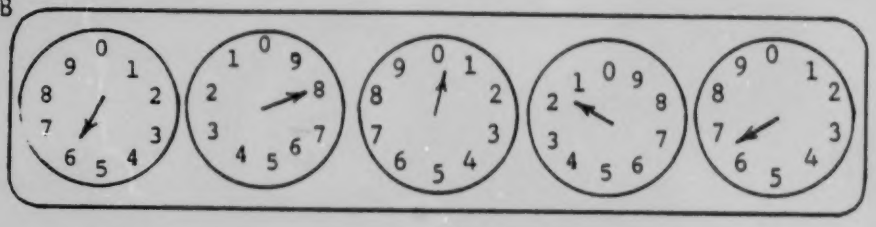
3. Now do the practice readings below and record your answers.

A



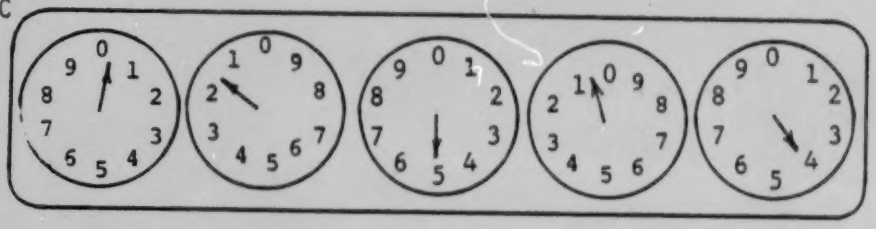
READING _____

B



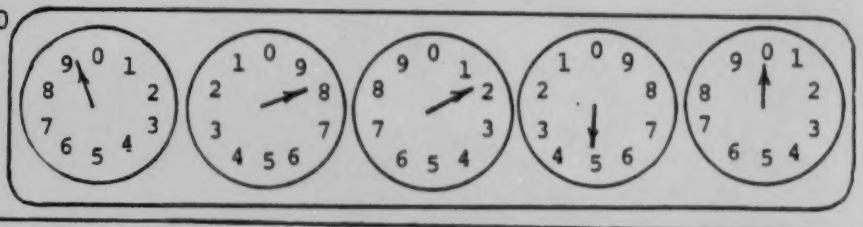
READING _____

C



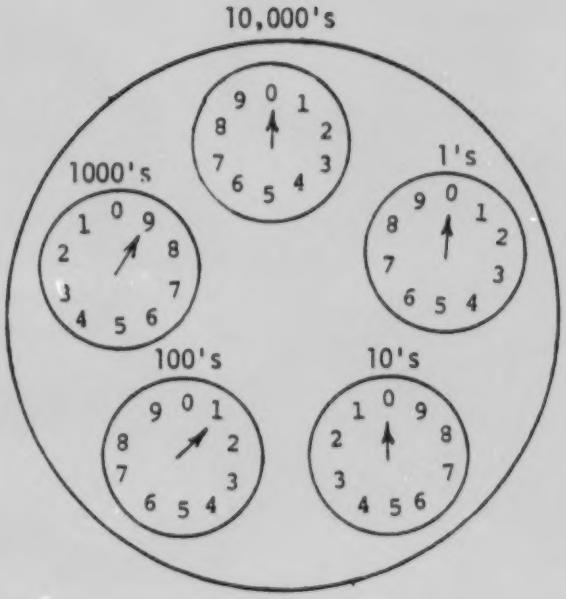
READING _____

D

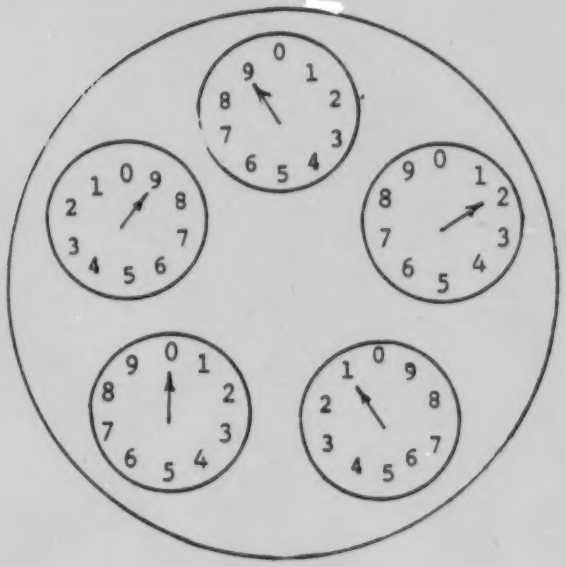


READING _____

Sometimes the dials are arranged in a ciruclar pattern. In that case, you read them in a circle, like this: ending with the dial at the top.



READING _____



READING _____

4. Calculate the kilowatt-hour electrical energy consumed if, on Day One, the meter read 09263 and on Day Two, the meter read 09282. To do this, simply subtract the Day One reading from the Day Two reading. How many kilowatt-hours have been used? (kwh)

5. Now you are ready to read the meter at home. You should make the readings at the same time each day for one week. Record this information, plus the activities in the house which used a lot of electricity that day. Use Data Sheet A to record your data, logging this information as seen in the example below.

DATA	TIME	ELECTRIC METER READING (kwh)	KILOWATT-HOURS USED DAILY	LOG
Oct. 23	9:00 PM	09263		3 baths, dishwasher, 2 loads laundry, cold day

6. From your data, calculate the total amount of electrical energy used for the first week and record below:

Week One: Amount used _____(kwh)

Now, think of several things you could do to conserve electricity in your home. Introduce these practices to your home for the second week. Repeat meter readings for the second week and record the information again on Data Sheet A. Determine the electricity used during this week and record below.

Week Two: Amount used _____(kwh)

7. List those steps taken during Week Two to conserve electrical energy consumption on the back of Data Sheet A.

8. Find out the price of electricity per kilowatt-hour in your community and determine the cost of electrical energy used during Week One and Week Two. Record below:

Week One: Electrical cost _____

Week Two: Electrical cost _____

LOOKING BACK

If people can train themselves to be aware of their energy use rather than consuming without thinking, we will have taken a significant step towards solving our energy problems. Each individual effort can make a difference.

QUESTIONS

1. Compare the amounts of electricity used during the first and second weeks. Is there any difference? How much?

2. How do you account for this difference?

3. Were your conservation efforts successful? If not, try to explain why.

4. Do you feel that you had to change or lower your life style in any way during your conservation efforts? Could you do more? Will you continue this effort?

5. Did your conservation efforts result in any cash savings during the second week? If so, how much?

6. Did your use of electricity during the second week go up, in spite of your efforts to conserve? Can you explain why?

GOING FURTHER

- Institute several more conservation measures and carry the experiment on for a few more weeks.

- Have a class contest to see who can save the most electricity.

- As a class, calculate the entire amount of electricity everyone saved. If all the classes in the school were to save this same amount, how much would be saved?

- Calculate how much the above would amount to in cash savings.

- Try to estimate electrical and cash savings, based on your figures, for the community, state, and nation.

- Consider and discuss ways that electricity could be saved in the school.

DATA SHEET A

USE OF ELECTRICITY

DATE	TIME	ELECTRIC METER READING (kwh)	KILOWATT - HOURS USED DAILY	LOG

Teacher Information Sheet

READING A METER

Suggested Grade Level and Discipline

Science 7-9
Physical Science
General Science

Background Information

One of the most prominent issues facing society today is that of energy conservation. In a society such as ours, economics will probably prove to be the most effective motivation for altering energy consumption habits. Simple arithmetic and common sense should convince almost everyone that, without undue sacrifice and discomfort, much forethought and cooperation will make it possible to have and afford the energy we require. Probably the most dangerous misconception is that the miracle of technology will solve our energy problem without any effort on our part as individuals.

The ability to read an electric meter is a useful tool for any consumer. Once you become aware of how much electricity you are using and how you are using it, energy conservation practices can be introduced.

Hints on Gathering Materials

- Obtain a meter model from the local power company. If a meter is unavailable, use a transparency, or make models (teacher and/or student constructed) with movable hands (use oatmeal containers and paper fasteners).

Suggested Time Allotment

- One period for introduction, passing out data sheets, displaying models, etc.
- Two weeks of out-of-class time, with check-ups at intervals in class to make sure students are recording data.
- One class period to analyze and discuss results.

Suggested Approach

- During the first class period, display the demonstration electric meter and instruct the class on how to read the dials. Check the Meter Worksheet to make sure that all students can read the dials correctly.

- Assign each student to read his/her electric meter at home as prescribed in the directions.

- Students may need some assistance in choosing ways to conserve electrical energy in their homes. A class discussion late in the first week could be used to suggest conservation methods for the second week. Suggestions might include:

  Washing in cold water (laundry)
  Shorter showers and less volume flow
  Lowered thermostats on hot water heaters
  Setting heating thermostats at 68°F (60°F at night and when home is unoccupied)
  Setting cooling thermostats at 78°
  Filling dishwashers before using
  Turning lights off in unoccupied rooms

Typical Results

- A decrease in weekly consumption of electricity should be noted at the end of the second week.

Precautions

- *Make sure that parents have been notified so that you have their cooperation.*

- *Consider provisions for students who live in apartment buildings and who might not have access to meters.*

- *Some students may have electrically-heated homes. During cold weather, daily changes in meter readings may reflect outside air temperatures much more than any conservation practices.*

Modifications

- None

Evaluations

- Using sample meter readings, check to see that students have correct readings.

- At end of first week, check students data sheets to make sure that readings have been done and that calculations are correct.

- Check student conservation measures. Are they reasonable?

References

Energy Conservation in the Home, An Energy Education/Conservation Curriculum Guide for Home Economics Teachers, U.S. Department of Energy, Technical Information Center, P.O. 62, Oak Ridge, Tennessee 37830.

Award-Winning Energy Education Activities, Department of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830.

How to Conserve Energy at Home, Niagara Mohawk Home Service Department, Niagara Mohawk Power Corporation, 300 Erie Blvd. West, Syracuse, New York 13202.

How to Save Money by Insulating Your Home, Federal Energy Administration, 12th and Pennsylvania Avenue, Washington, D.C. 20461.

How Do You Rate as an Energy Saver, Niagara Mohawk Power Corporation, 300 Erie Blvd. West, Syracuse, New York 13202.

Energy, Directory and Bibliography, Consumer Action Now's Council and New York State Alliance to Save Energy, Inc., 355 Lexington Avenue, 16th Floor, New York, New York 10017.

Media

Energy: A Matter of Choices, Encyclopedia Britannica, 425 N. Michigan Ave., Chicago, Ill. 60611.

Energy Conservation, WNET 13 Media Services, 356 West 58th Street, New York, New York 10019.

Measuring Electricity, (slides), Educational Design, Inc., 47 W. 13th Street, New York, New York 10011.

Star Wars Energy Series, New York State Alliance to Save Energy, 36 W. 44th Street, Room 709, New York, New York 10036.

A Thousand Suns, Arthur C. Barr Films, Purchasing Dept., 3490 East Foothill Blvd., Pasadena, California 91107.

ACTIVITY 5

TRADING CALORIES FOR KILOWATTS

INTRODUCTION

We are accustomed to using many electrical appliances in our homes. Some of them are a convenience but not an absolute necessity. We could perform the same service without using the electrical device or using it less often. This activity is designed to make you more aware of how energy can be saved by the elimination of devices or by reducing their use.

OBJECTIVES

At the completion of this activity you should be able to:

- o compare the energy required to perform tasks using electrical appliances with energy required using manual labor.
- o list expendable electrical appliances.
- o list ways of conserving electrical energy by less use of certain electrical appliances.
- o find the total contribution to energy savings you can make by elimination of or decreased use of some electrical appliances.

SKILLS AND KNOWLEDGE YOU NEED

- How to read data from a chart.
- How to tabulate data.
- How to perform the four basic mathematical operations on whole numbers and decimals.

MATERIALS

- Pencil and paper.
- Worksheet and Basic Data Sheet.

METHOD

Table A.

1. The attached Basic Data Sheet lists electrical appliances found in many homes. To save energy, people could use an item less or not use it at all. On Table A, list the items that you think your family could <u>stop using completely</u>.
2. Using the Basic Data Sheet, find the annual energy consumption of each one of these electrical appliances and list it in column I of Table A.
3. Add up column I of Table A. This shows you how much energy you could save by not using these appliances.

4. Using the Basic Data Sheet, find the annual energy consumption by the human body to do the work of the appliance, and list it in column II of Table A.

5. Add up column II of Table A. This shows you how much human energy you would have to use to replace the appliances on your list with human work.

Table B.

1. On Table B, list the appliances that you think your family could use less.

2. Using the Basic Data Sheet, find the annual energy consumption of each one of these electrical appliances and list it in column I of Table B.

3. Now estimate the percent reduction you plan for each appliance, and write it in decimal form in column II. (For example, if you think you could cut the use of your family's dishwasher by one third, write .33 in column II.)

4. You are now going to figure out how many kilowatt hours you will save, using the formula below and writing the answer in column III.

Column I		Column II		Column III
Annual Energy Consumption	X	Percent Reduction	=	Savings

5. Add up column III. This shows you how much energy you could save by reducing your use of these appliances.

6. Using the Basic Data Sheet, find the annual energy consumption by the human body to do the work of the appliance, and list it in column IV.

7. You are now going to figure out how many kilowatt hours of human energy you will have to use to reduce your use of each appliance. Use the formula below, and write your answer in column V.

Column IV		Column II		Column V
Human Energy Consumption	X	Percent Reduction	=	Human Energy Needed to Reduce Use of Appliance

8. Add up column V. This shows you how much human energy you would have to use to reduce the use of the appliances on your list.

***If you add the total energy saved from Table A and the total energy saved from Table B, you will see how much energy you could save overall if you stopped using some appliances and used other appliances less.

LOOKING BACK

Many people take our electrical gadgetry for granted. Others assume we cannot live comfortably without it. Careful planning can achieve a balance of energy conservation and "the good life." Each person can contribute calories today toward kilowatts for the future.

QUESTIONS

1. Which household appliance listed on your worksheet consumes the most energy? Which appliance requires the least energy?

2. Which appliances require less electrical energy than equivalent human body energy? Which require more?

3. What is the total number of kilowatt-hours of electrical energy you could save by the reduction in usage and the elimination of the devices you suggested.

4. The elimination of an electrical device may not result in the energy saving predicted on the data table. Why?

GOING FURTHER

- Conduct a personal energy audit for a two week period. Consider all the electrical energy you use and compare your total with others.

- Obtain the cost per kilowatt-hour from your local electric company. Calculate the money saved by your reduced usage and elimination of electrical appliances for a period of one year. Multiply this by the population of your community.

BASIC DATA SHEET

ELECTRICAL APPLIANCE	I ANNUAL ENERGY CONSUMPTION OF ELECTRICAL APPLIANCE (kwh/year)	II ANNUAL ENERGY CONSUMPTION OF HUMAN BODY PERFORMING THE TASK OF THE APPLIANCE (kwh/year)
Air conditioner	2000	NA
Food blender	15	1.6
Can opener	0.5	.7
Clothes dryer	1200	1.5
Dish washer	348	37.0
Electric blanket	147	NA
Electric knife	8	1.2
Electric shaver	1.8	4.7
Electric toothbrush	0.5	5.9
Floor polisher	15	8.5
Food waste disposer	30	1.2
Hair dryer	15	2
Lights (per home)	2000	NA
Mixer	13	1.4
Sewing Machine	11	148
Sun lamp	16	NA
Television (color)	540	NA
Television (b&w)	400	NA
Washing machine (automatic)	84	212

NA = Not Applicable

TABLE A

Electrical appliances that you could stop using completely.		
Appliance	Column I Annual Energy Consumption by Appliance (See I on Data Sheet)	Column II Annual Energy Consumption by Human Body Performing Work of the Appliance (See II on Data Sheet)
	+	+
	Total_____ kwh/year Energy saved by not using these appliances.	Total_____ kwh/year Human energy used to replace appliances with human work.

TABLE B

Electrical appliances that you could use less.					
Appliance	Column I Annual Energy Consumption by Appliance (See I on Data Sheet)	Column II Percent Reduction (in decimal form)	Column III Savings in kwh	Column IV Annual Energy Consumption by Human Body (See II on Data Sheet)	Column V Human Energy Needed to Reduce Appliance Use
			+		+
			Total kwh/year		Total kwh/year
			Energy saved by reducing use of these appliances.		Human energy needed to reduce appliance use.

5-7

Teacher Information Sheet

TRADING CALORIES FOR KILOWATTS

Suggested Grade Level and Discipline

7-12 Physical Science
General Science
General Math

Background Information

Energy conservation is a topic most often encountered in a physical science course. However, all living systems require energy, transform energy, and use energy. This exercise focuses on the student as a source of biochemical energy which can be used to help alleviate our overdependence on electrical energy.

Column II on the Basic Data Sheet contains rough estimates whose values are calculated in the following manner:

Can Opener Example:

$$\frac{1.6 \text{ Kcal}}{\text{min}} \times \frac{700 \text{ can}}{1 \text{ yr}} \times \frac{.5 \text{ min}}{\text{can}} = \frac{560 \text{ Kcal}}{\text{yr}}$$

- $\frac{1.6 \text{ Kcal}}{\text{min}}$: Human body energy needed to open a can
- $\frac{700 \text{ can}}{1 \text{ yr}}$: Number of cans opened in one year
- $\frac{.5 \text{ min}}{\text{can}}$: Time needed to open one can

Since 1 kilowatt-hour = 853 Kilocalories

$$\frac{560 \text{ Kcal}}{\text{yr}} \times \frac{1 \text{ Kilowatt-hour}}{853 \text{ Kcal}} = .7 \frac{\text{kilowatt-hours}}{\text{yr.}}$$

Students should be made aware that the kilowatt-hour data is based upon averages, and that these calculations are estimates.

Hints on Gathering Materials

- Ask students to list the appliances in their homes before beginning the activity.
- Obtain the cost of electricity from the local electric company.

Suggested Time Allotment

- Approximately one class period to develop and discuss the worksheets.

Suggested Approach

- First discuss the Basic Data Sheet with the students. (It may be useful to explain how the values for kilowatt-hours/year have been calculated.)
- Explain how the Student Worksheet should be completed by recording two entries in Tables A and B with the entire class.
- Ask students to complete the worksheet individually, assisting those who need help.
- Discuss the students' responses to the questions as a group exercise.

Typical Results

- There will probably be great variation among individual lists of suggested reductions, eliminations, and savings. Some students may wish to expand the list on their Basic Data Sheet. If so, they should consult publications such as those listed as references.

Precautions

- *Students should be reminded to express their percentage reduction in decimal form, (i.e., 25% - .25).*

Modifications

- None

Evaluations

- Review students' lists during class summation. Are their choices realistic? Are the reductions attainable?
- Observe student ability to follow directions and defend choices logically and/or arrive at a compromise.
- Collect and review worksheets for organization and accuracy.

References

Care of Adult Patients, Smith and Germain, p. 688, J.P. Lippincott Co., Philadelphia, 1975.

How to Save Energy and Money in Your Home, Energy Workbook #1, New York State Energy Office, Agency Building 2, Empire State Plaza, Albany, New York 12210.

Manual on Energy Conservation, Draft form, Atmospheric Sciences Research Center, SUNYA, Albany, New York, 12222.

ACTIVITY 6

CONSERVING HOME ENERGY

INTRODUCTION

The conservation of energy resources has become a high priority for our nation. The direct savings in money is perhaps the least important reason for adopting wise conservation measures. More serious reasons exist.

One reason is inflation. Growing demand for and consumption of electrical energy have strained our fuel supply, requiring the use of more fuel of a lower grade. Costs have been driven up and the problem of reducing air pollution has become more difficult. The construction of needed power plants with more air pollution controls is expensive and costs are passed on to the consumers. These added costs contribute to inflation which decreases the purchasing power of the dollar.

Furthermore, using energy unnecessarily is a crime against future generations. The fossil fuels used to generate electrical energy cannot be replaced. Without adequate supplies of oil, coal, and natural gas the cost of energy will become very high and future standards of living will decline. Through involvement in the activities below, you will become more aware of the many ways in which electricity is used in the home, and which of these require the most energy. A study of electrical energy usage there should permit you to develop and put into use a home electrical energy conservation plan.

OBJECTIVES

At the completion of this activity you should be able to:

- o graph home energy consumption over a period of time.
- o interpret variations in home energy consumption from the graph.
- o develop a plan to reduce energy consumption in the home.

SKILLS AND KNOWLEDGE YOU NEED

- Recognize wattage rating on appliances.
- Recognize and read electric and gas meters.
- Develop and interpret a bar graph.
- Infer usage patterns from data.

MATERIALS

- Electrical appliances.
- Electric and gas meters.
- Rulers

METHOD

1. Using Worksheet A, make a list of the electrical devices in your home and the electrical power of each. Power is expressed in watts and is usually indicated on each device. (If not indicated, calculate wattage by using the formula: watts = amps x volts). Also list appliances using natural gas.

2. Using Worksheet B, make a record of electrical meter readings in your home at the same time each day for at least three weeks. Make a note of any appliance which is only used on a certain day, or is used very heavily on a certain day. The reading of the meter will be in kilowatt hours (kwh). To find the energy used each day, subtract the reading of the day before from the current day's reading.

3. Using Worksheet C, make a record of gas meter readings in your home if gas is used as a fuel. Take readings at the same time each day for at least three weeks. The reading of the meter will be in cubic feet (cu.ft.). To find the energy used each day, subtract the reading of the day before from the current day's reading.

4. On Worksheets B and C, graph the electrical and gas energy used, as a function of each day. Note that energy used is on the vertical axis and the day is on the horizontal axis. Make bars to represent the energy used.

5. Now interpret your graphs for Worksheet B and C. Try to find a pattern of energy consumption. Account for any variations in consumption over the period of time that data was collected.

6. Develop a plan for reducing the electrical and gas energy consumption in your home. Compare your plan with others.

7. Review Worksheet A and discuss whether your plan can significantly reduce your home energy consumption.

LOOKING BACK

Home electrical and gas usage is seldom monitored by owners, even though such efforts often pay a dividend in energy and cost savings. Using objective measures to record and interpret such data has allowed you to develop a plan for reducing the energy consumed in your home.

QUESTIONS

1. What appliance consumes the greatest amount of electrical energy in your home?

2. What is the major gas consumer in your home?

3. What steps could you and your family take to conserve energy?

4. Is there a difference between conserving energy and reducing energy consumption?

5. Are those appliances having the highest watt rating really the major consumers of electrical energy? (For example, using hot water and a razor to shave may use more energy than an electric razor.)

GOING FURTHER

- Assist others in developing energy conservation plans.
- Assemble the most workable ideas into a pamphlet for the school and community.
- Organize a broader school-based energy conservation campaign and tabulate before and after readings in order to document the savings by those members of the community who participate.
- Implement your plan to reduce energy consumption in your home and evaluate results.

WORKSHEET A

Household Appliance Inventory

Column I: Electrical Device	Column II: Rated Wattage
Natural Gas Device	

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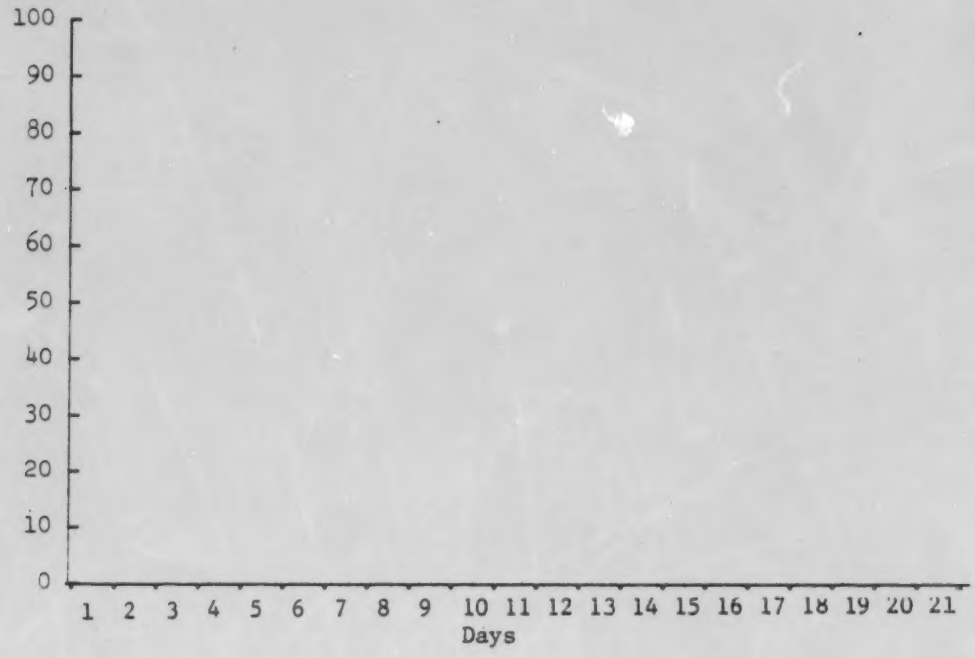
WORKSHEET B

Daily Usage Patterns - Electricity

Energy Used:

Electricity In Kilowatt Hours

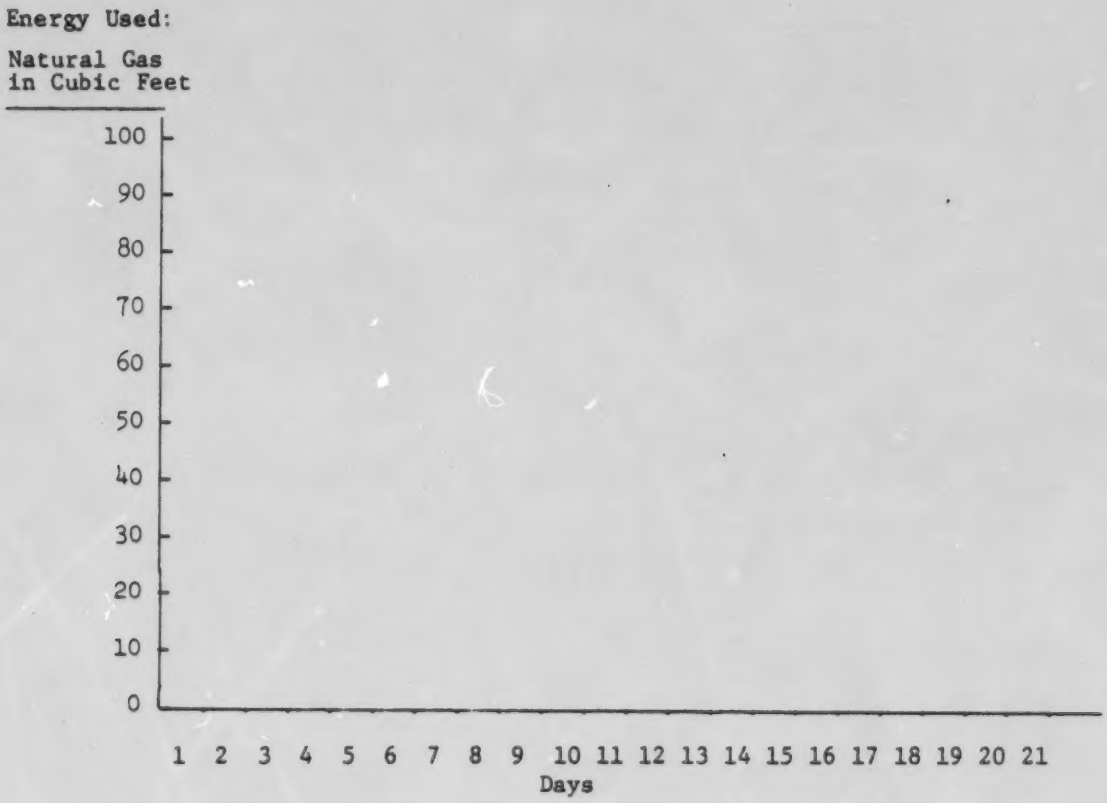


Energy Used:

Day	Date: Day/Month	Meter Reading (kwh)	Difference Between This Day and Previous Day
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

WORKSHEET C

Daily Usage Patterns - Natural Gas



Energy Used:

Day	Date: Day/Month	Meter Reading	Difference Between This Day and Previous Day
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

Teacher Information Sheet

CONSERVING HOME ENERGY

Suggested Grade Level and Discipline

8-12 Science
Physical Sciences
Physics

Background Information

Many students have only very sketchy knowledge about electrical energy. They may know little beyond the facts that homes have electrical meters which reflect the number of types of electrical devices used and that these meters are read to arrive at a utility bill. Students should realize that electrical energy consumption is not indicated by the meter reading itself but rather by the differences between successive readings.

The amount of energy used in kilowatt hours as indicated by the meter, represents the rate of using energy (kilowatts) times the period of use (in hours). The rate of energy use by a device is called its power. It is expressed in watts (1,000 watts equal one kilowatt) and is indicated by the manufacturer on each device or in the instruction booklet. Students should gain an understanding of both the wide range of powers of electrical devices used in the home and the durations of their use.

Hints on Gathering Materials

- It is advisable that a packet of energy saving tips for homeowners be obtained from various organizations such as local utilities and energy agencies.
- Be sure to have rulers on hand for the bar graphing.

Suggested Time Allotment

- This project will require at least three weeks, but actual classroom time may be minimal.
- Establish checkpoints with students and review their progress along the way.

Suggested Approach

- Assign these activities as a home project and spend a few minutes in class each day reviewing procedures and sharing results.
- Upon completing the data collecting phase, provide sufficient class time for the interpretation of student graphs and the development of home energy conservation plans.

- To ensure the best efforts of students, it is advisable to provide classroom resources that facilitate their activities. Bulletin boards might contain related clippings and reading references and the Reader's Guide to Periodical Literature should direct students to magazine articles dealing with energy conserving procedures (e.g., washing clothes in cold water, air drying of dishes and clothes, reducing light bulb wattages, and taking showers instead of baths).

Typical Results

- Results will be highly variable due to different fuel sources for space and water heating and the diverse patterns of home appliance use.

- Students may have difficulty understanding question #4. The idea of simply reducing the energy consumption in contrast to using energy more wisely should be stressed in reviewing this question.

Precautions

- *Students should be advised not to tamper with meters.*

- *Be aware that gas meters may vary in units. (i.e., some may require that cu. ft. be multiplied by x10, or x100.)*

- *Be sensitive to the fact that many students will not introduce energy saving measures that will cause discomfort to their families. Be sure to inform parents about the nature of the activity to obtain their cooperation.*

- *Parental value systems may have an effect on students' suggestions for saving energy.*

- *If homes are electrically or gas heated, then during cold weather, graph data will reflect the energy being used to heat the home much more than the appliance use. Under these circumstances, energy will be more a function of outside temperature than anything else, and students may not see very satisfactory results from their conservation efforts.*

Modifications

- Options may have to be made for students who do not have individual family electric or gas meters.

- It might be interesting to encourage competition for the best savings in electrical energy or for the most effective display of the results.

Evaluation

- Collect student worksheets with graphs. Check for accuracy.
- Be aware that the validity of student plans may be less important than the actual experience gained by performing this activity.
- Review the topic of home energy conservation several months subsequent to the completion of this activity to ascertain if changes in energy use patterns have persisted.

References

104 Ways to Control Your Electric Bill; Guide to Wise Use of Energy for Electric Heating and Cooling; Annual Energy Requirements of Electric Household Appliances, Edison Electric Institute, 90 Park Avenue, New York, NY 10016.

ACTIVITY 7

KEEP THE HEAT

INTRODUCTION

The design, construction, and maintenance of your home, school, or office have an important effect on how much energy is used to keep it warm in winter or cool in summer. An energy-saving structure will be more comfortable than a wasteful building, and since it will use less fuel, it will cost less to heat or cool.

This activity considers the idea of heat energy conservation in a building. You will be using checklists to identify measures that help or hurt energy conservation in a selected building. During the walk-through, you should consider each statement separately and be attentive to those things that appear to be wasteful of energy and those things that appear to be in keeping with good conservation.

OBJECTIVES

At the completion of this activity you should be able to:

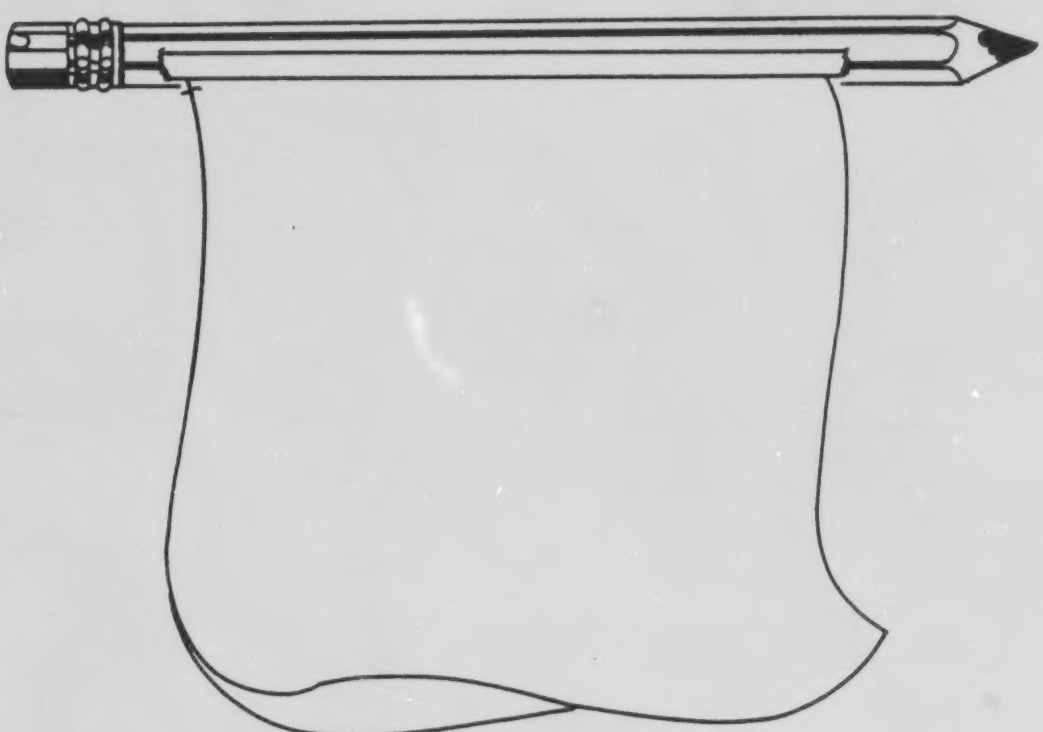
- o identify the major construction, maintenance and design features that make a building energy efficient.
- o define and use each of the vocabulary terms discussed in this unit while explaining energy savings steps to a homeowner.

SKILLS AND KNOWLEDGE YOU NEED

- Familiarity with the basic construction of a dwelling.
- Working vocabulary of terms used in discussing energy conservation.

MATERIALS

- Data Sheets A and B.
- Pencil, tape, and tissue paper, tissues, or thin plastic to make a draft meter as shown in the diagram.



METHOD

1. Using Data Sheet A and Data Sheet B, complete the observations on your home, apartment, or a dwelling suggested by the teacher.

2. Develop a sheet listing ways to improve energy conservation in the home or apartment that was studied. List alternatives whenever possible, so that the homeowner has choices in making conservation improvements.

3. Compare observations with other students in order to improve your study. Revise your improvements sheet based on these discussions.

LOOKING BACK

You have just looked at some features which make a building an energy saver or an energy waster.

Most buildings have many places where heat escapes. Some of these can be easily patched and sealed at little cost. Other features which were built in during the original construction will be more difficult and more expensive to alter. Buildings of the future will have to be constructed with much more concern for energy use than there has been in the past.

QUESTIONS

1. Why are most building lots landscaped the way that they are? Do good energy conservation principles seem to be generally used?

2. The locations of most windows in a dwelling are related to the need for light inside and the desire of those designing the home for balance and appeal. What effect would conservation practices have on window locations?

3. For what purposes is hot water really needed in a home? What are the reasons for many people using more hot water than they really need?

GOING FURTHER

- Take photos of good conservation practices and poor conservation practices related to a building that you have studied. Arrange the photos of poor practices next to diagrams that illustrate how they can be eliminated. Photos of good practices could be displayed with captions explaining why they are good.

- In a single color, sketch the landscape around a building that you have observed. Using a contrasting color, sketch in planting that may improve energy conservation.

- Design a blueprint or model of a building which incorporates the energy conservation features you have identified.

DATA SHEET A

Interior Observations

Directions: Go through the building room by room. Do not overlook any space. Keep a check-off list of rooms to be sure all spaces are examined. Give specific answers. Examples:

"Three of the six rooms have rugs."
"There was one faucet dripping."

1. Are the ceilings insulated? _____
2. Do the rooms have acoustic tile or cork on the ceiling? _____
3. Are the floors insulated? _____
4. Do the rooms have rugs? _____
5. Are the walls insulated? _____
6. Is the furniture placed so it does not block the heating or cooling ducts?

   _____
7. Are the thermostats located on inside walls? _____
8. Are the walls and ceilings light in color so as to reflect available light?

   _____
9. Are the ceilings no more than average height? (About 8 feet) _____
10. Are there insulating drapes or other window coverings? _____
11. Are these drapes or coverings closed at night? _____
12. If there is a fireplace in the house, does it have a damper? _____
13. Is the damper closed when the fireplace is not in use? _____
14. Does the draft meter show windows and doors to be draft free? _____
15. Does the draft meter show other openings to the outside to be draft free?

    _____
16. Does the draft meter show that the openings in electrical outlets are draft free? _____
17. Are faucets free from drips? _____
18. Are flow restrictors installed on showers? _____
19. Has a clock thermostat been installed for automatic set back at night? _____
20. Are hot water pipes in the cellar area insulated? _____
21. Are warm air ducts in the cellar area insulated? _____

DATA SHEET B

Exterior Observations

1. Are there few windows on the north side? _____
2. Do the largest windows face south? _____
3. Does the roof overhang supply summer shade but allow winter sun? _____
4. Are there storm windows or other double glazings on the windows? _____
5. Are doorways provided with a double door? _____
6. Are doors sheltered by an entry hall alcove? _____
7. Are evergreen shrubs and trees used as windbreaks around the house, particularly on the north and west sides? _____
8. Are leaf-shedding trees planted on the south side for summer shade and winter sun? _____
9. Are insulating materials used in the attic and basement? _____
10. Are all cracks caulked? _____
11. Are attic vents available to cool attic space in the summer? _____
12. Are foundation walls free of cracks or holes? _____
13. Are windows caulked? _____

Teacher Information Sheet

KEEP THE HEAT

Suggested Grade Level and Discipline

7-9 Physical Science
Earth Science
General Science

Background Information

For a nation with a small population (6% of the world's), the United States uses an enormous amount of energy, about a third of the energy produced each year on the planet. As Wilson Clark stated in his book "Energy for Survival: the Alternative to Extinction," it's as if every American citizen had 300 laborers working 24 hours a day for him alone."

Such a situation cannot continue to exist. Moral considerations aside, the United States cannot afford to continue on such a course. Nor will the rest of the world continue to tolerate such a monopolization of its resources.

There are many alternatives, but not all are very attractive. To give ourselves the best chance at maintaining a comfortable standard of living, we must develop awareness and habits of conservation. That is what this activity seeks to develop.

Hints on Gathering Materials

- A supply of tissues, tissue paper, or thin plastic and tape should be available for students' use in developing their draft meters.

Suggested Time Allotment

- One class period for data taking.
- One homework assignment for developing the sheet of improvements.
- One class period for discussing and revising the sheet of improvements.

Suggested Approach

- Be sure that students are familiar with the vocabulary used in the exercise. Demonstrate making and using the draft meter. Describe the techniques that students will use in making the necessary observations in their homes.

- Consider using a set of photographs or a "home-like" classroom such as the home economics suite as a preliminary exercise to give students some initial experience.

- Where possible, allow students to make observations in pairs.

Typical Results

- Observations will vary depending upon the design, age, and maintenance of the buildings under examination.

- Students should be able to list several methods to conserve energy in homes, based upon their analyses.

Precautions

- *It is advisable to notify parents of your students in advance if inspection of their homes is planned.*

- *If a commercial building is to be studied, obtain permission well in advance of the observation.*

Modifications

- While this activity focuses upon residential dwellings, slight modifications of procedures and checklists could make it appropriate for industrial, commercial, or agricultural buildings.

- Have students make observations on each other's homes and share the improvement sheets with one another.

Evaluation

- Ask students to show you their completed Data Sheets before preparing the improvements sheets.

- Collect and examine the improvements sheets for feasibility of applications.

- Prepare a survey six months subsequent to the activity to identify any improvements made in home energy conservation by your students.

References

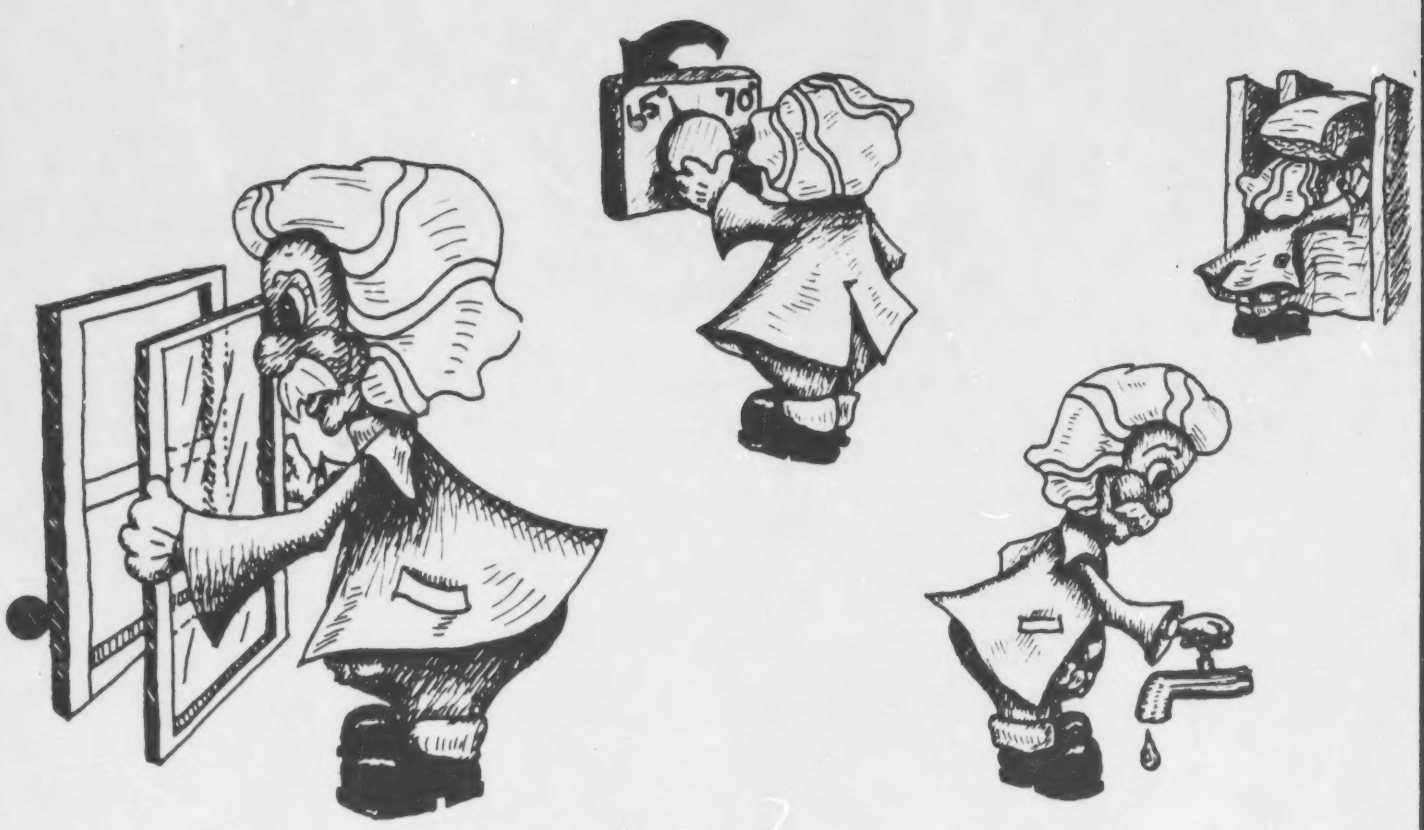
Tips for Energy Savers, Energy Conservation Now, Pueblo, Colorado 81009.

Total Energy Management: A Practical Handbook on Energy Conservation Management, Office of Energy Policy and Programs, US Department of Commerce, Washington, DC 20230.

How You Can Save Energy in Your Home, New York State Electric and Gas Corporation, Binghamton, New York 13902.

ACTIVITY 8

MINI ACTIVITIES IN ENERGY CONSERVATION



INTRODUCTION

Do you think that you and your family are wise energy consumers? Maybe you feel that one family can't really make a difference to our country's energy problems. Each of the worksheets in this activity focuses on one area of energy use in the home. Using these worksheets as guides, you will discover that people can do something about the problems of energy.

OBJECTIVES

At the completion of these activities you should be able to:

- o rank home appliances by their energy consumption.
- o describe ways to reduce dependence on appliances.
- o estimate how many BTU's you use when bathing.
- o describe energy-saving measures related to bathing.
- o describe methods of saving some of the energy we use to heat and cool our homes.

SKILLS AND KNOWLEDGE YOU NEED

- Determining liquid volume.
- Converting units in problem solving.

MATERIALS

- Worksheets provided.
- Bathtub.

METHOD

- Complete the worksheets as directed by your teacher.

LOOKING BACK

How do you rate as an energy consumer? Did you find examples of energy waste in your home? Sometimes, what seems like an enormous problem becomes manageable when we stop to think about it. That should be the first step in any energy conservation plan. Analyze how and why you are using energy. Then take steps to become a better energy user.

GOING FURTHER

- Design your own "mini-lessons" on energy conservation.

- Construct a scrapbook of pictures and/or articles. Possible themes could be:

  Energy in the News
  Wise Uses of Energy: Ways to Conserve
  Energy Thieves: Are You a Culprit?
  Energy International

- Compare the sources of energy presently used in the home to those employed by nineteenth-century Americans.

- Predict how the home of the future will obtain sufficient energy to meet domestic needs.

WORKSHEET 1

PULL THE PLUG

1. Listed below are twelve common appliances. Using the numbers 1-12, rank these appliances according to the amount of energy you think each consumes in a year. (1 = the least energy consumed, 12 = the most energy consumed.)

2. Check Reference Tables A and B and consumer guides to find the actual ranking. Use annual kilowatt-hour consumption. How accurate were you?

Appliance	(1) Your Ranking	(2) Actual Ranking
Hair dryer (Hand-held)		
Carving Knife		
Stereo/hi-fi		
Refrigerator/freezer		
Automatic coffee maker		
Color TV		
Dishwasher		
Clothes dryer		
Washing machine		
Toaster		
Microwave oven		
Hot water heater		

3. List as many methods as you can for decreasing the energy consumption of these appliances.

4. Which jobs performed by these appliances can you readily perform in a way that would reduce energy consumption?

WORKSHEET 2

C L E A N A N D C H E A P

1. Measure the length and width of your tub or shower stall IN FEET. Record below.

2. The next time you bathe, measure the depth of the water - OR - the next time you shower, close the drain and measure the depth of water that accumulates. Record below IN FEET.

   length = _____ft., width = _____ft., depth = _____ft.

3. Multiply these three measurements (be sure you use feet, or fractions of feet) to obtain the total VOLUME of water used (l x w x d = volume).

   Volume = _____cubic feet

4. 1 cubic foot of water equals approximately 8 gallons of water. Convert cubic feet to gallons below.

   _____cu.ft. x 8 gal/cu.ft. = _____ gallons of water

5. The amount of energy required to heat the water differs, depending on the type of water heater:

   electric water heater set at 140°F = 2700 BTU's/gal.

   gas or oil water heater set at 140°F = 1200 BTU's/gal.

   (140°F is probably the setting for your water heater)

   Calculate the number of BTU's required to heat the water for your bath/shower.

   _____ gallons of water x _____ BTU's/gal =
   (2700 or 1200 - depending on your water heater)

   _____BTU's

6. List as many methods as you can for decreasing the energy you consume when bathing. (No bathing is <u>not</u> allowed as a choice.)

WORKSHEET 3

HOT AND COLD

1. Listed below are some energy-saving suggestions related to home heating or cooling. Place a check next to those you and your family practice:

   _____ avoid blocking heating vents with draperies and furniture.

   _____ close the damper on your fireplace chimney when not in use.

   _____ wear more clothing in cold weather.

   _____ set thermostat at 68^{o}F during the day.

   _____ turn thermostat down to 60^{o}F at night.

   _____ keep air-conditioning set at 78^{o}F.

   _____ have furnace cleaned regularly.

   _____ use weather stripping around doors and windows.

   _____ use storm windows or thermopane glass.

   _____ use insulated drapes.

2. Which measures do you think are most important? Using only those measures you practice, rank them from MOST IMPORTANT to LEAST IMPORTANT. Compare your list with those of your classmates.

3. List any other "energy savers" that you practice. Compare your ideas with your classmates.

REFERENCE TABLE A

ANNUAL ENERGY REQUIREMENTS OF ELECTRIC HOUSEHOLD APPLIANCES

APPLIANCES	AVERAGE WATTAGE	ANNUAL kwh CONSUMPTION	ANNUAL COST @ 4¢/kwh
Air cleaner	50	216	$ 8.64
Air conditioner (room)	997	1,032*	41.28
Bed covering	177	147	6.88
Blender	386	15	.60
Broiler	1,436	100	4.00
Carving knife	92	8	.32
Clock	2	17	.68
Clothes dryer	4,856	993	39.72
Coffee maker	894	106	4.24
Deep fryer	1,448	83	3.32
Dehumidifier	257	377	15.08
Dishwasher	1,201	363**	14.52
Egg cooker	516	14	.56
Fan (attic)	370	291	11.64
Fan (circulating)	88	43	1.72
Fan (window)	200	170	6.80
Floor polisher	305	15	.60
Freezer (15 cu.ft.)	341	1,195	47.80
Freezer, frostless (15 cu.ft.)	440	1,761	70.44
Frying pan	1,196	186	7.44
Hair dryer (hand held)	381	14	.56
Heater (portable)	1,322	176	7.04
Heating pad	65	10	.40
Hot plate	1,257	90	3.60
Humidifier	177	163	6.52
Iron	1,008	144	5.76
Mixer	127	13	.52
Oven (microwave)	1,450	190	7.60
Radio	71	86	3.44
Radio/record player	109	109	4.36
Range, with oven	12,200	1,175	47.00
Range, with self-cleaning oven	12,200	1,205	48.20
Refrigerator/Freezer (14 cu.ft.)	326	1,137	45.48
Refrigerator/Freezer, frostless (14 cu.ft.)	615	1,829	73.16
Roaster	1,333	205	8.20
Sandwich grill	1,161	33	1.32
Sewing machine	75	11	.44
Shaver	14	1.8	.072
Sun lamp	279	16	.64
Television (black and white), tube type	160	350	14.00
Television (black and white), solid state	55	120	4.80
Television (color), tube type	300	660	26.40

ANNUAL ENERGY REQUIREMENTS OF ELECTRIC
HOUSEHOLD APPLIANCES (Continued)

APPLIANCES	AVERAGE WATTAGE	ANNUAL kwh CONSUMPTION	ANNUAL COST @ 4.6¢/kwh
Television (color, partial solid state)	200	440	$ 17.60
Toaster	1,146	39	1.56
Toothbrush	7	0.5	.02
Vacuum cleaner	630	46	1.84
Waffle Iron	1,116	22	.88
Washing Machine (automatic)	512	103**	4.12
Washing Machine (manual)	286	76	3.04
Waste disposer	445	30	1.20
Water heater (standard)	2,475	4,219	168.76
Water heater (quick-recovery)	4,474	4,811	192.44

* Based upon 1,000 hours of operation per year; this figure will vary widely depending on geographic area and size of unit.

** Does not include kilowatt-hours for heating water.

NOTE: kwh = Kilowatt-hour
= 1,000 watts/hour

SOURCE: All figures courtesy of Electric Energy Association, New York, New York, 1973, and the Tennessee Energy Office, 1975.

Teacher Information Sheet

MINI-ACTIVITIES IN ENERGY CONSERVATION

Suggested Grade Level and Discipline

6-12 Multidisciplinary
Physical Science
General Science

Background Information

The crisis in energy supply and demand will require homeowners as well as businessmen to determine ways to conserve fuels and electricity. Each of these worksheets is designed to interest students in solving our energy problems.

All three mini-activities encourage group discussion and transmitting energy information to students' families. They should be considered as "springboards" to a host of similar inquiries into home energy conservation.

Hints on Gathering Materials

- Have texts or consumer guides available which list energy requirements of appliances (Worksheet #1). One reference is supplied.
- Check with government agencies (DOE, ERDA) or utility companies for pamphlets which support the worksheets.
- Request materials far enough in advance.

Suggested Time Allotment

- The entire package would probably take one class period in addition to home preparation time.

Suggested Approach

- The package can be used as a whole, or the worksheets can be used separately. If used individually, each worksheet will take only part of a class period and can be accompanied by other activities, (e.g., a film on energy conservation).
- Parts of the worksheets may be assigned for homework, or the necessary information (e.g., Worksheet #2 - tub dimensions) could be brought to class and transferred onto the worksheets.
- It is important to give adequate time for class discussion of the worksheets. Sharing of student ideas is essential to meeting the objectives.

Typical Results

- Worksheet #1: Students will often be surprised to learn which appliances expend the greatest amount of electricity and begin to consider frequency in their use more carefully.

- Worksheet #2: Results will vary with bathtub dimensions and water volume preferences. In most cases, showers will be shown to be less energy consuming than baths. Remind students that the water heater is one of the highest energy-consuming items in the household. (The U.S. Department of Energy recommends that water heaters be set at 120°F.)

- Worksheet #3: The relative importance of the suggestions will vary with the home conditions the students assess. The discussion of the ranking is more important than the arrival at any pre-determined sequence.

Precautions

- *The calculations in Worksheet #2 assume that the water is used at 140°C. The actual BTU's used can be calculated by the following ratio:*

$$\frac{2700 \text{ BTU's}}{140^{\circ}F} = \frac{? \text{ BTU's}}{\text{Temperature of bath water } ^{\circ}F}$$

Modifications

- A "contest approach" might be used with Worksheet #1. Who is the most "energy-wise"?

- A classroom bulletin board could be used to both introduce and reinforce energy conservation topics.

- Worksheets could be re-designed using school equipment and facilities as targets for analysis.

Evaluation

- Quiz the students on their ability to rank appliances based on energy consumption (after Worksheet #1 is completed).

- Collect and check Worksheet #2. Are measurements and calculations accurate? Are suggested energy-saving methods reasonable?

- During group discussions, are students presenting reasonable suggestions? Are their arguments logical?

- Has there been a noticeable change in students' attitudes towards and their awareness of energy consumption?

References

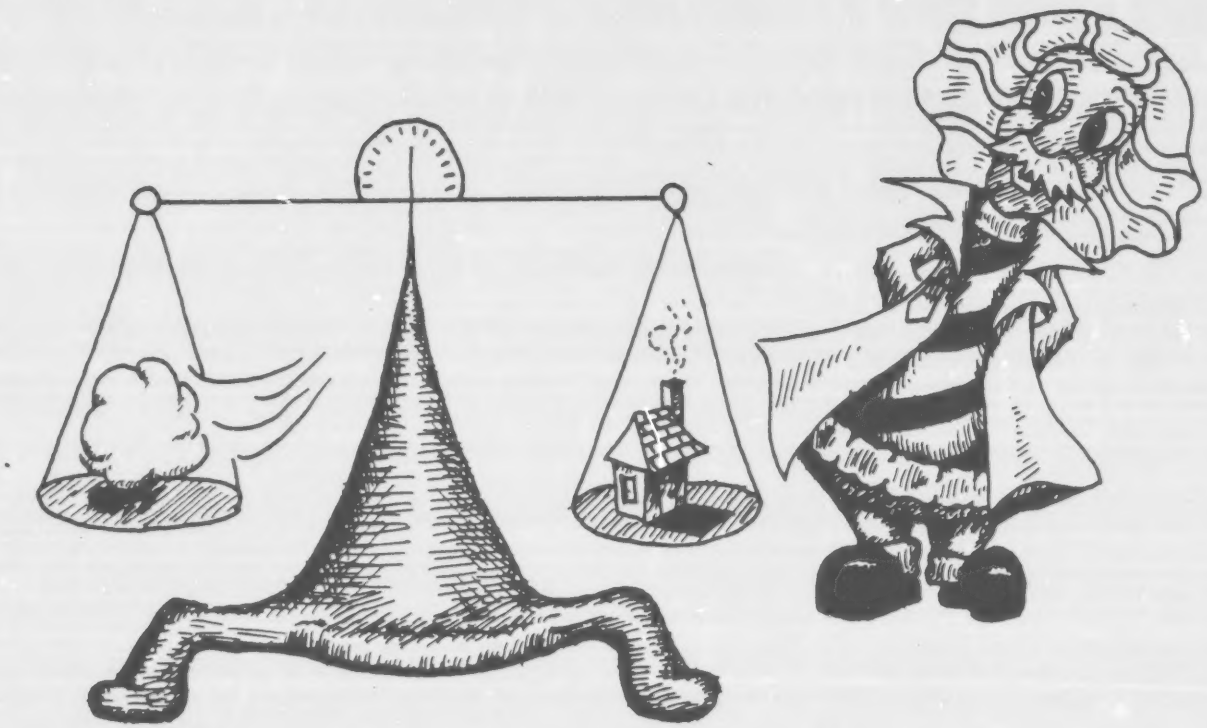
Save Energy and Money, Pamphlet distributed by Power Authority of the State of New York and New York State Energy Office, Agency Building 2, Empire State Plaza, Albany, NY 12224.

Tips for Energy Savers, Energy Conservation Now, Pueblo, Colorado, 81009.

Energy Conservation: Experiments You Can Do, Thomas Alva Edison Foundation, Cambridge Office Plaza, Suite 143, 18280 West Ten Mile Road, Southfield, Michigan 48075.

ACTIVITY 9

HEAT BALANCE



INTRODUCTION

Both commercial and residential buildings lose heat by radiation to the cooler air surrounding them. The amount of heat loss occurring depends upon such factors as sidewall and ceiling surface areas, number and type of windows and doors, and thickness of insulation.

In this activity, you will be determining the heat loss of a single-story dwelling and calculating the amount of heat necessary to balance this loss for a given outside temperature.

OBJECTIVES

At the completion of this activity you should be able to:

- o cite the major factors that cause heat loss from a dwelling.
- o carry out a heat loss calculation for a dwelling.
- o calculate the heat requirements in BTU's per day for a dwelling.

SKILLS AND KNOWLEDGE YOU NEED

- Computing two-dimensional areas; i.e., windows and floors.
- Using values in simple formulas to calculate products and quotients.

MATERIALS

- Measuring tape or yardstick.
- One-story dwelling.

METHOD

I. Data Collection: Record measurements on numerically corresponding parts of Data Sheet A.

1. Measure the perimeter of the dwelling in feet (P).
2. Measure ceiling height of first floor in feet (H).
3. Measure area of all windows in square feet (W). Note whether they are single pane, storm, or thermo-pane windows. Sliding glass doors should be treated as windows.
4. Measure area of all doors in square feet (D). Note whether storm doors are utilized. Windows in doors may be ignored.

5a. Measure area of floors in square feet (F).

5b. The computation above will also be the area of the ceiling (C).

6. Measure the thickness of ceiling insulation in inches (CI).

7. Measure the thickness of sidewall insulation in inches (SI).

II. Computation of Heat Loss: Use Data Sheet B II and the the Table of Heat Loss Factors to compute the heat losses for the following:

8. Sidewalls

   a. Determine Total Sidewall Area = P x H
   b. Determine True Sidewall Area = Total Sidewall Area - Window and Door Areas = (P x H) - (W + D)
   c. Determine Sidewall Heat Loss (True Sidewall Area x HLF)

9. Determine Window Heat Loss (W x HLF)

10. Determine Door Heat Loss (D x HLF)

11. Determine Ceiling Heat Loss (C x HLF)

12. Determine Floor Heat Loss (F x HLF)

13. Add the values of steps 8c through 12 to determine the Total Heat Loss in BTU's/hr at 0^{o}F outside temperature.

III. Calculation of Heat Balance: Use Data Sheet B III.

14. Assume your dwelling is maintained at 65^{o}F. Calculate the number of BTU's necessary to balance the heat loss for a 24 hour day per ^{o}F by employing the formula below:

$$\text{Heat Balance (BTU/}^{o}\text{F day)} = \frac{\text{Total Heat Loss (BTU/hr)} \times 24 \text{ hr/day}}{65^{o}}$$

Record this value on Data Sheet B III.

15. The Heat Balance obtained in step 14 may now be used to calculate the number of BTU's needed to heat the dwelling relative to outside temperature. For instance, suppose the heat balance as calculated in step 14 is 20,000 BTU/^{o}F day and the outside temperature is 40^{o}F. Then to heat this dwelling for one day the BTU's necessary would be (65^{o} - 40^{o}F) = 25^{o} x 20,000 BTU/^{o}F = 500,000 BTU's/day. Calculate this quantity for the temperature assigned by the instructor and record the results on Data Sheet B III.

LOOKING BACK

Major factors contributing to heat loss of a building are directly related to its construction, including its insulation and the outside area. Heat lost by a building to the outside can be partially controlled by adjusting either or both of these factors.

QUESTIONS

1. Consider the example in step 15 of the method in which the heating system was rated at 20,000 BTU/^{o}F day. The temperature drops to 20^{o}F. What would the residents of the building notice? Show the calculations which support your conclusion.

GOING FURTHER

- Compare the estimated heat balance with the actual heat balance by using the table showing the number of BTU's obtainable from a gallon of fuel oil, a cubic foot of gas, or a kilowatt of electricity. Multiply this BTU value by the amount of fuel consumed in a 24 hour period.

- Prepare a histogram showing the daily heating requirements for the homes of pupils in your class for an assigned outside temperature. From these, determine a total daily heat requirement for your community.

- Make an analysis of the daily heating needs of a multiple story dwelling.

- Some dwellings which have been insulated well and whose owners have taken steps to reduce heat losses will have heating systems which were designed for a once drafty and heat-leaking house. These heating systems are possibly "over-powered" and inefficient for the re-designed insulated homes. What factors should be considered in replacing such heating systems?

DATA SHEET A

I.

1. P (Perimeter) Sum of lengths of outside walls — P = _____ ft.
2. H (Ceiling Height) — H = _____ ft.
3. W (Window Areas):

(Check here if storm windows are used.) ☐

l	x	w	=	area	Use this space for calculations
	x		=		
	x		=		
	x		=		
	x		=		
	x		=		
	x		=		
	x		=		

W = Window Area Total = _____ sq. ft.

NOTE: Sliding glass doors are treated as windows.

4. D (Door Area):

(Check here if storm door is used.) ☐

	x		=		
	x		=		
	x		=		

D = Door Area Total = _____ sq. ft.

5a. F (Floor Areas):

	x		=		
	x		=		
	x		=		
	x		=		
	x		=		

F = Floor Area Total = _____ sq. ft.

5b. C Ceiling Area Total (Same as floors) — C = _____ sq. ft.

6. CI Thickness of Ceiling Insulation — CI = _____ in.

7. Thickness of Sidewall Insulation — SI = _____ in.

DATA SHEET B

II. HEAT LOSSES

8a. Sidewall area (rough) P x H _____ (Use data from steps 1 and 2)

8b. Sidewall area (same as above)_____

minus Total Window Area (step 3) _____

minus Total Door Area (step 4) _____

= True Sidewall Area _____

8c. True sidewall area x HLF (Use HLF listed on Table) _____ x _____ = _____
(HLF is Heat Loss Factor)

9. Window area x HLF (W x HLF) _____ x _____ = _____

10. Door area x HLF (D x HLF) _____ x _____ = _____

11. Ceiling area x HLF (C x HLF) _____ x _____ = _____

12. Floor area x HLF (F x HLF) _____ x _____ = _____

13. Total 8c, 9, 10, 11, and 12
(This represents the total Heat Loss in BTU/hr at $0^{o}F$) _____

III. HEAT BALANCE

14. Heat Balance = $\frac{\text{Total Heat Loss(step 13) x 24 hrs/day}}{65^{o}F}$ = _____ $BTU/^{o}F$ day

15. Temperature assigned = _____ ^{o}F

Number of BTU's needed - ($65^{o}F$ - Assigned Temperature ^{o}F) x Heat Balance $BTU/^{o}F$ day to Heat Dwelling
= _____ BTU's/day

TABLE OF HEAT LOSS FACTORS

Sidewalls:	
no insulation	18
2 inches fiberglass	9
3 5/8 inches fiberglass	5
Doors:	
solid wood	34
solid wood with storm	23
Floors:	
concrete slab	7
floor over space not insulated	10
floor over space with fiberglass	4
floor over heated basement	0
Windows:	
single pane	79
double pane or single with storm	48
Ceilings:	
no insulation	22
3 5/8 inches fiberglass	6
6 inches fiberglass	4
10 inches fiberglass	2
14 inches fiberglass	2

TABLE OF BTU VALUES OF VARIOUS FUELS

Natural gas - 1 cubic foot = 1000 BTU's

Propane - 1 gallon = 91,500 BTU's

Distillate fuel oil - 1 gallon = 139,000 BTU's

Electricity - 1 kilowatt hour = 3,412 BTU's

Teacher Information Sheet

HEAT BALANCE

Suggested Grade Level and Discipline

11, 12 Science electives on energy
Physics
Math

Background Information

Heat loss can be defined as U, the Coefficient of Heat Transmission, or the amount of heat transferred in one hour through one square foot of building structure for each degree Fahrenheit of temperature difference between the inside and outside of the structure. U = 1/R where R equals the R-value of the materials composing the structure.

$$U = BTU's/(hr)\ (ft^2)\ (^\circ F)$$

In this activity, total Heat Loss is first determined for a structure at $0^\circ F$, using a given heat loss factor (Method 13). The heat loss factor was found by $(65^\circ F/R)$, and when multiplied by area, gives Heat Loss in BTU's/hr at $0^\circ F$.

This Heat Loss is then converted to $BTU/(^\circ F)(day)$(Method #14). The number of BTU's needed to heat the dwelling per day relative to outside temperatures is then calculated from this. An inside temperature of $65^\circ F$ is assumed throughout.

The heat losses considered in this activity include only those due to insulation factors and outside surfaces. They do not take into account losses that may occur as a result of infiltration, or factors such as the number of occupants, exposure, or wind velocity. Heat gains from appliances, occupants, lighting, and insulation are also not accounted for, but may be added to this module as needed.

This exercise should first be conducted on a building that is easily accessible by students. Students may work in pairs or groups, and calculations may be criticized and reviewed by the entire class. Once this has been accomplished students may use the module to measure heat losses in their own homes as a required project to be turned in at a specified time.

Measurement is in the English system since most available data in this area in the United States is largely given in English units. Conversion to metric, while desirable, may be cumbersome.

Hints on Gathering Materials

- Use a tape measure if possible.
- Gather data for ceiling insulation thickness and sidewall insulation thickness (steps 6 and 7 of procedure) by actual measurement or by consultation with the homeowner.
- Use a one-story rectangular house the first time. Two-story houses may require two perimeters if the dwelling is a split-level.
- Use a volunteered home near the school or an outbuilding on the school grounds. Measure heights of very tall roofs or ceilings indirectly by taking the heights of a single brick, clapboard, etc. and multiplying by the number observed up the side of a building.

Suggested Time Allotment

- 2-3 weeks, with much of the work to be done as assignments outside of class time.

Suggested Approach

- Have students work in groups with each group doing windows, doors, floors, etc.
- Check the accuracy of group heat balance calculations by plotting a frequency distribution of the values obtained.

Typical Results

- Similar dwellings can be compared to check accuracy of the work.
- Discrepancies in the actual amounts of heat used versus the amount calculated will certainly arise because of the rough estimates used in calculating HLF's and weather, infiltration and solar gain factors, as well as others.

Modifications

- Calculations for this activity can be made from a scale diagram or from a photograph of a building. Blueprints can also be substituted.
- This activity assumes that the characteristics of doors, windows, floors, sidewalls, and ceilings are uniform throughout the dwelling. The teacher may wish to make the calculation of heat losses more elaborate by varying their specifications.

Evaluation

- Check the student's accuracy and care during the activities.
- Compare student results with teacher results on the same dwelling.

References

Energy Conservation, Booklet TL190, SUNY Stony Brook, Stony Brook, NY 11790.

In the Bank or Up the Chimney, US Department of Housing and Urban Development. (Reprinted by various utility companies). Available from Public Relations Office, Niagara Mohawk, 300 Erie Blvd. West, Syracuse, NY 13202.

Buying Solar, US Government Printing Office, Washington, DC, 20402. (Stock No. 041-018-00120-4) (Source for BTU equivalents for various fuels).

ACTIVITY 10

INSULATION TESTING

INTRODUCTION

Why is it that some houses have small heating needs while others of the same size use so much fuel? Insulation often makes all the difference.

In this activity you will compare the insulating ability of several different materials.

OBJECTIVES

At the completion of this activity you should be able to:

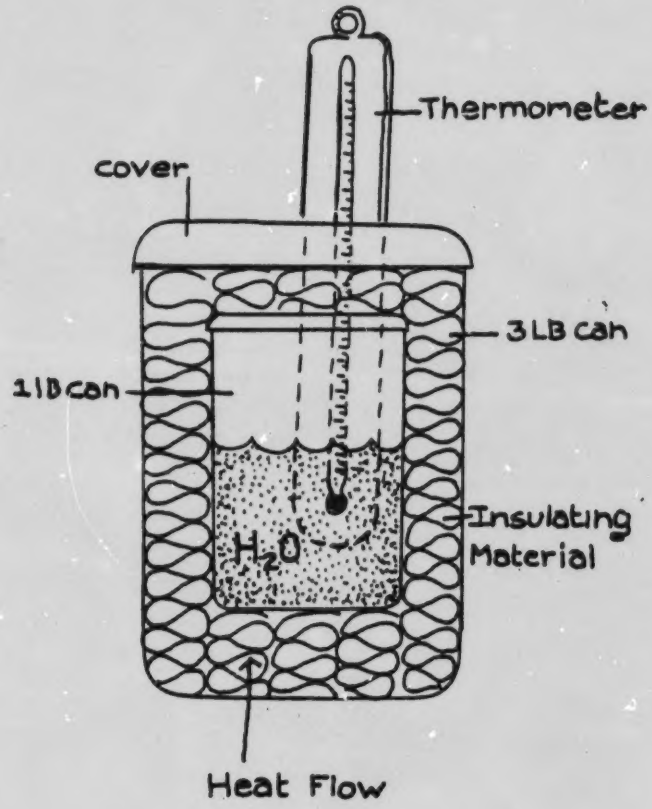
- o construct a device to be used in measuring the effectiveness of insulation materials.
- o compare the insulating abilities of various materials.

SKILLS AND KNOWLEDGE YOU NEED

- How to read a thermometer and a clock or timer.
- How to measure liquids using a graduated cylinder.
- How to construct and interpret graphs.

MATERIALS

- A standard laboratory calorimeter or a 3 lb. coffee can and a one lb. coffee can, both with plastic lids.
- One thermometer.
- One ring stand.
- One bunsen burner.
- A clock or timer.
- Insulating materials, such as vermiculite, styrofoam, urethane foam, fiberglass, cellulose, sand, paper, etc.
- Safety goggles and gloves.



METHOD

1. Assemble your insulation tester:

   a. Using a punch, place a hole in the plastic lids of the two coffee cans.

   b. Place a layer of one kind of insulation around the inside and on the bottom of the 3 lb. can in such a way that the one lb. can fits inside comfortably. (See diagram.) Other students will use different insulation materials.

   c. Place the one lb. can inside the 3 lb. can.

   d. Place 300 ml. of water at room temperature in the one lb. can.

   e. Place the plastic lids on the cans.

   f. Carefully insert the thermometer through the holes in the two lids.

2. Place the insulation tester on a ring stand.

3. Record the temperature of the water.

4. Light the bunsen burner with a low flame and place under the insulation tester.

5. Record the temperature every one-half minute for ten minutes on Data Table A.

6. Plot the change in temperature vs. time on a graph. Compare your results to the results of those students who used other insulating materials.

7. Calculate the approximate rate of heat flow per minute by dividing the change in temperature over ten minutes by ten.

8. If time allows, repeat the activity for different kinds of insulation. Compare the performance of various insulations on the same graph.

LOOKING BACK

In this activity, the flow of heat through different materials was compared. The greater the rise in the temperature of the water, the poorer the insulating ability. Insulation designed to be used in homes and buildings is rated for its resistance to heat flow. The "R" value on commercial insulation products is a measure of the material's resistance to heat flow. The larger the "R" value, the greater the resistance to heat loss and the better the insulation.

QUESTIONS

1. Based on your observations, which materials rate best as insulators?

2. What properties did the best insulators have in common?

3. From the data collected, which material has the highest "R" value?

GOING FURTHER

- What effect would the thickness of the insulating layer have on the heat flow? Construct a modified apparatus to test the variable. Use different thicknesses and different materials.

- What would be the effect of combining two different insulating materials?

- What might be some of the sources of experimental error in the measurements of heat flow you made with this apparatus? How could these be reduced?

- Find out what type of insulation you have in your home. How does it compare with others tested in this activity?

DATA TABLE A

TIME (min)	MATERIAL A	MATERIAL B	MATERIAL C
	temp. ^{o}C	temp. ^{o}C	temp. ^{o}C
0			
.5			
1			
1.5			
2			
2.5			
3			
3.5			
4			
4.5			
5			
5.5			
6			
6.5			
7			
7.5			
8			
8.5			
9			
9.5			
10			

Teacher Information Sheet

INSULATION TESTING

Suggested Grade Level and Discipline

7-12 Science
Physics

Background Information

There are a number of factors which determine the effectiveness of insulators. The type of material is a major consideration. The density of the insulation and its water vapor content are two other important variables. The number of small enclosed "dead" air spaces is still another. R-value is the measurement used to communicate insulating capacity.

The most common types of insulation are fiberglass, mineral wool, and cellulose that has been treated with chemicals to retard flammability. Various foams sold in sheets or processed on site are gaining in popularity. Homes built before the last decade often have 1½ inches of insulation in the ceilings and none in the walls. Properly insulated ceilings have the potential for reducing heat losses by 20%.

Hints on Gathering Materials

- Most physics labs have commercial calorimeters which are suitable for this investigation. The metal containers are good thermal conductors and are less apt to contribute to errors than glass containers, which themselves are insulators.

- Insulating materials can be gathered from a variety of sources. Science equipment is often packed in styrofoam or vermiculite.

Suggested Time Allotments

- One 20-minute period to go over instructions, assemble equipment, set up lab notebooks, break up into groups and assign timer, recorder, etc.

- One 40-minute period to conduct the activity, copy and exchange results, etc.

Suggested Approach

- Break students up into groups of 4-5 students.
- Have each group investigate a different type of insulation.
- Students should be encouraged to do two trials and average results.
- Have students follow the method from step 1 to step 5 for different materials or different trials with the same materials. The graphing can be assigned as out of class work.
- Students not familiar with graphing can be directed to skip steps 6 and 8.

Typical Results

- Using a set of 10-minute trial runs, the following heat flow values were obtained:

  fiberglass - 1.44 degrees per minute
  air - 2.80 degrees per minute
  paper - 2.0 degrees per minute

Precautions

- *Use a medium to small flame on bunsen burner. Keep flame temperature as consistent as possible on all trials.*
- *Make sure students wear safety goggles.*
- *Be careful not to melt plastic lids.*
- *Keep thermometer from touching sides and bottom of can.*
- *Insulation should be packed loosely in the coffee cans. Use gloves.*
- *Pretest the process using your heat source and a moderate flame, as the insulation may char under high heat.*
- *CAUTION: foamed plastic board insulation is highly flammable, as is styrofoam unless it has been treated with a flame retardant.*

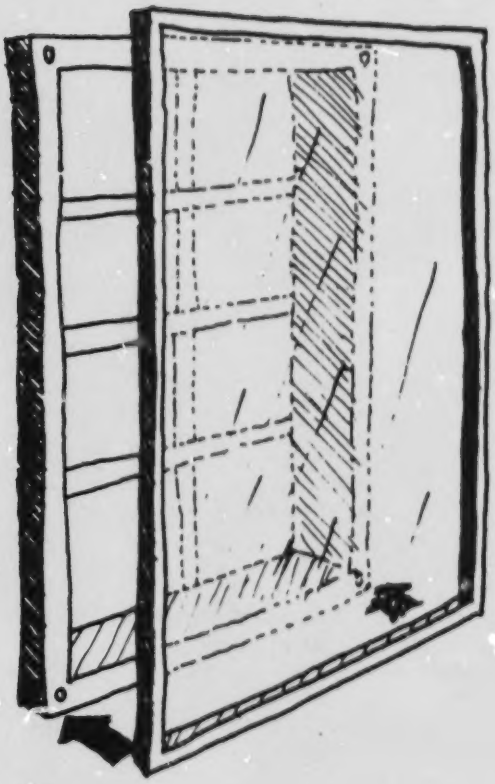
References

Solar Energy Experiments for High School and College Students, Thomas Norton, Rodale Press, Emmaus, Pennsylvania, 1977.

Science Activities in Energy Conservation, Oak Ridge Associated University, USDE EDM-1049

ACTIVITY 11

CONSERVING HEAT WITH GLAZING



INTRODUCTION

Many dwellings, public buildings, and business establishments have been constructed with large window areas to admit more light, add beauty, and allow the great outdoors to be seen from inside. Yet a major source of heat loss from a building is through this window area.

The purpose of this activity is to examine the effect of added window insulation on the temperature of an internal space. What effect does a second layer of window glazing (glass or other transparent substance) have on the flow of heat energy from a room? Is it possible to keep the positive features of window and still reduce the heat loss? We will begin to answer such questions in this activity.

OBJECTIVES

At the completion of this activity you should be able to:

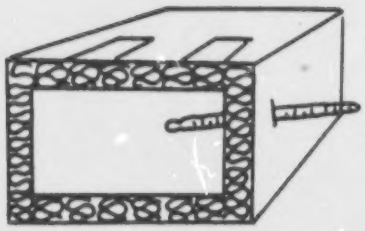
- o contrast the heat loss from a warmer system to a cooler area when single and double glazings are used.
- o describe the insulating properties of various glazings.

SKILLS AND KNOWLEDGE YOU NEED

- Reading a thermometer.
- Recording data on a chart.
- Constructing graphs.
- Interpreting data.

MATERIALS

- Two boxes of different sizes -- the smaller one a shoe box. Arrange them so that one will nest inside the other with space for insulation between.
- Insulation can be:
  - Newspaper
  - Fiber glass
  - Foam sheets
  - Mineral wool, etc.
- Glazings (glass, polyethylene, saran wrap) to fit over the boxes.
- A supply of hot water, 300 ml. beaker, thermometer, tongs, and paper.
- Graph paper.



tape hinges for glazing

insulation

glazings placed over front

METHOD

1. Nest the two boxes with insulation between them, so as to make the inside box insulated.

2. Cut holes for a thermometer that will pass from outside through to the center of the inside box. (Cut the hole so that the thermometer is within 1 inch of the glazing). See diagram above.

3. Place a glazing over the inside box and fix in place with masking tape or duct tape on one side so as to act as a hinge. See diagram of outside hinges.

4. Using the tongs, place a container of very hot water in the smaller box to act as a heat source. Close the box.

5. Record the temperature outside the box. Then insert your thermometer and record the temperature in the inside box at two minute intervals for twenty minutes. Record on the Data Sheet.

6. Now, using a fresh supply of hot water, place a second glazing of the same or different material over the outside box using taped hinges. Be sure that the smaller box with its glazing is recessed inside the larger box so that 1 inch of air space is between the glazings.

7. Once again record the temperature in the inner box at two minute intervals for twenty minutes. Record this on the Data Sheet.

8. Plot the data obtained on graph paper. (Temperature vs. time).

9. Repeat steps 3-8 for different combinations of glazing materials if time permits.

LOOKING BACK

You have run a test of what occurs when an enclosed space such as a building has window surfaces that are single glazed and double glazed. The heat and cost savings over many hours, days, and weeks are significant.

QUESTIONS

1. Which type of glazing allowed the heat to escape fastest from the box?

2. Which type of glazing appeared to be the best heat insulator?

3. Inspect the graphs; what do the curves tell you about the usefulness of glazing?

4. Compare the losses in heat energy with a one glazing unit to those with a two glazing unit. Record the drops in temperature over twenty minutes for each and forecast the results that you would obtain with a triple glazing. Are triple glazings useful?

5. Graph the temperature versus time for each student group's situation on the same graph paper. What do the curves say about the usefulness of various combinations of glazing?

GOING FURTHER

- Try this approach with different sized containers and varying insulation materials.

- Place a cooled box (refrigerated) outside with the sun facing the glass. Repeat the data tabulation and graphing for the single and double glazed conditions. Does double glazing make sense when cooling an interior space surrounded by warm temperatures?

DATA SHEET

Glazing material(s)?	1. _____ _____	2. _____ _____	3. _____ _____	4. _____ _____
Single or double?				
Beginning Temperature				
2 minutes				
4 minutes				
6 minutes				
8 minutes				
10 minutes				
12 minutes				
14 minutes				
16 minutes				
18 minutes				
20 minutes				

Teacher Information Sheet

CONSERVING HEAT WITH GLAZINGS

Suggested Grade Level and Discipline

9-12 Physical Science
General Science
Physics

Background Informations

The use of glazings can significantly alter the heat flow through window areas. Energy savings ultimately depend upon the integrity of the air space between the glazed surfaces. Adding two, three, or four glazings should show gains in R value great enough to be detected by students.

The efficiency of glazings will be most apparent when there are significant temperature differences on opposite sides of the glazings.

Hints on Gathering Materials

- Try nesting different box sizes. Discarded styrofoam boxes in which electronic equipment is shipped or picnic chests are useful options.
- Saran wrap, poly film, fiberglass, and glass may be used for glazings.
- Be sure to have sufficient quantities of the Data Sheet and graph paper available.

Suggested Time Allotment

- Three class periods and a single homework assignment. (One period to complete each 20 minute sequence on the data table including set-up time and a third period for class discussion).
- More time will be necessary if other glazing combinations are to be tested.

Suggested Approach

- Allow students to work in groups with different glazing materials. Ensure that students collect their data with all conditions controlled except for the pertinent variables.

- Have students compare their results. Tabulate as many of the variables as possible to encourage class discussion. This analysis of class data should focus upon the questions.

Typical Results

- Results will depend on the difference between "inside" and "outside" temperatures.
- Student results may show only slight differences between single and double glazing.
- Water vapor in the dead air space between glazings reduces its insulation quality.
- Temperatures in the box will usually show an initial increase and then decrease.

Precautions

- *If glass is to be used for glazing, edges must be sanded or covered with heavy tape and care used to avoid accidents and injury.*
- *Large temperature differences on opposite sides of the glazing are important when illustrating the efficiency of glazings.*

Modifications

- Have physics students calculate heat flow in kilocalories and encourage a more sophisticated, mathematically-based discussion.

Evaluation

- Evaluate data sheets and graphs by inspection.
- Evaluate the class discussion through listening and asking students to make inferences from their data.

References

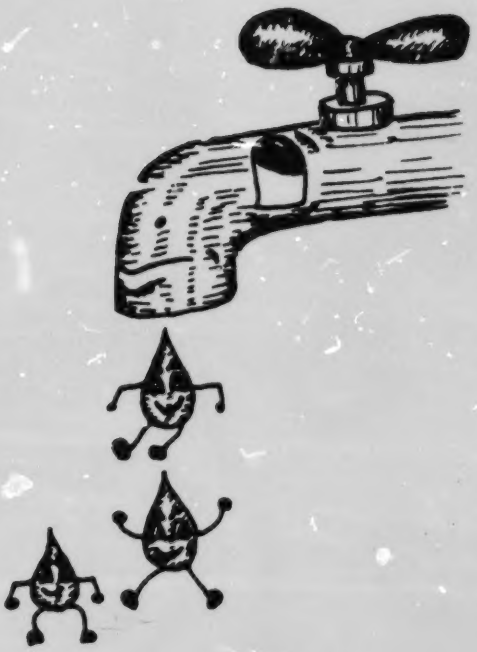
Passive Design Ideas for the Energy Conscious Consumer, National Solar Heating and Cooling Information Center, PO Box 1607, Rockville, Md. 20850.

Project Retrotech: Instructor's Kit for Home Weatherization Course, Federal Energy Administration, Washington, DC 20461.

How to Save Money by Insulating Your Home: Practical Instructions and Advice. Federal Energy Administration, Washington, DC 20461.

ACTIVITY 12

HOT WATER LOSS



INTRODUCTION

About twenty percent (1/5) of the energy used in a home for heating is directed to the hot water system. As much as half of this hot water may be wasted in some homes. In this activity you will investigate a major cause of water waste and calculate the savings realized when some action is taken.

OBJECTIVES

At the completion of this activity you should be able to:

- o calculate the heat energy lost through dripping water taps.
- o represent heat losses in equivalent quantities of fuel.

SKILLS AND KNOWLEDGE YOU NEED

- Being aware of the law of energy conservation.
- Converting between metric units of volume.
- Accurate use of a graduated cylinder.
- Accurate use of a thermometer.
- Knowledge of unit measures of heat energy.
- Using algebraic equations in calculations.

MATERIALS

- Small container.
- 100 milliliter graduated cylinder.
- Celsius thermometer.

METHOD

1. Place a container under a dripping hot water tap and collect liquid for 15 minutes. Use a graduated cylinder to determine in milliliters the volume collected. Record below:

   Hot water collected: _____ ml/15 minutes

2. Calculate the amount of water lost in this way during one year by making the conversions below:

_____ ml/15 minutes x 4 = _____ ml/hour

_____ ml/hour x 24 = _____ ml/day

_____ ml/day x 365 = _____ ml/year

_____ ml/year ÷ 1000 ml/liter = _____ liters/year

3. Run the cold water tap and record the cold water temperature:

_____ ^{o}C

4. Run the hot water tap and record the hot water temperature:

_____ ^{o}C

5. The heat required to raise the temperature of a given volume of water is expressed by:

$$Q = mc\ \Delta t$$

Where Q represents heat energy in Kilocalories; m represents the mass of water in Kilograms; c is the specific heat of water (1 Kilocalorie per Kilogram per ^{o}C); and Δt is the difference in temperature between the hot and cold water in ^{o}C.

Calculate the heat required to raise one liter of water to the temperature of your hot water tap. (1 liter of water has a mass of 1 Kilogram)

$Q = mc\ \Delta t$

Q = 1 Kilogram x 1 Kilocalorie/Kilogram ^{o}C(t hot - t cold)

Q = 1 Kilocalorie x (step 4 - step 3)

Q = _____ Kilocalories per liter

6. Now determine the amount of heat required to warm the water lost from your dripping hot water tap during one year:

$$\text{Heat required} = \frac{\text{Kilocalories}}{\text{liter}} \times \frac{\text{Liters}}{\text{year}} = \frac{\text{Kilocalories}}{\text{year}}$$

This value represents the heat energy expended due to the dripping tap during one year.

7. Assuming that 1 Kilocalorie is approximately equivalent to 4 BTU's, convert the heat expended in Kilocalories to BTU's:

$$\text{Heat Expended} = \frac{\text{Kilocalories}}{\text{year}} \times \frac{\text{4 BTU's}}{\text{Kilocalorie}} = \frac{\text{BTU's}}{\text{year}}$$

8. Determine the type of energy source for the water heater (electricity, natural gas, or heating oil), and calculate the quantity used to heat the water lost by dripping.

Electricity: 1 kwh = 3,400 BTU's
Natural gas: 1 cu.ft. = 1,000 BTU's
Heating oil: 1 gal. = 139,000 BUT's

$$\text{Quantity used in heating wasted water} = \frac{\text{BTU's}}{\text{year}} \div \frac{\text{BTU's}}{\text{unit of fuel}} = \frac{(\quad)}{\text{year}}$$

LOOKING BACK

The amount of energy used in heating water in the typical home is substantial. Consider the waste if only ten percent of the taps in your community leak water. The annual energy debt and fuel consumption become significant.

QUESTIONS

1. Assume that each home in a community of 1,000 homes has four hot water taps. What would be the total energy wasted each year if 10% of these taps dripped at the rate observed in this activity.

GOING FURTHER

- How does a person learn to fix a leaking tap? Where is the information? What are the skills required?
- Find the costs, per unit of energy purchased, to heat the water losses calculated in the activity. This information can be obtained from the organization that sells the energy or from a sample bill. Calculate the annual cost of a "drip". With which type of energy source is the wasted water most expensive to the homeowner?
- Calculate the total cost of dripping taps for the community described in question 1.
- Calculate the cost for your community.

Teacher Information Sheet

HOT WATER LOSS

Suggested Grade Level and Discipline

9-12 Science
Physical Science
Physics
General Physics

Background Information

The hot water budget is a significant factor in home heating costs. The law of heat exchange can be applied to the common situation of dripping water taps and help students understand the significance of the waste when extrapolated from the fifteen minute observation to an entire year. Carrying the extrapolation further, a guess as to how many people permit this situation to exist will yield a still larger figure when predicted for the community or the nation.

Some students will recognize that much of the heat loss in hot water from the tap takes place at an uninsulated storage tank near the furnace or boiler. More losses occur along uninsulated pipe runs to the taps. The figures that result from this exercise, then, are conservative and do not account for these losses. The real losses are greater.

Hints on Gathering Materials

- This activity may substitute for a heat exchange laboratory exercise. Graduated cylinders, thermometers, and student sheets will be sufficient.

Suggested Time Allotment

- One class period plus time for repeating the activity at home.

Suggested Approach

- The activity assumes that the students have an understanding of energy conservation in the law of heat exchange and are familiar with the concepts that support $Q = mc\ (t_f - t_i)$.
- Because the English system of units is used in many engineering studies related to fuels and energy, there is a conversion from metric to English units in this activity.

Typical Results

- If the calculations are completed correctly, BTU's of heat expended for the water lost from different taps should be similar in quantity.

- Some variation will result if the dripping taps are not at the same temperature. This will be the case when students use different taps, different locations, or do not let the water heat the pipe runs coming to the tap.

- To find out with which energy source the wasted hot water is most expensive, it will be necessary to have on hand the current costs for one kilowatt hour of electricity, one gallon of home heating oil, and one cubic foot of natural gas.

Precautions

- *Repair the leaking tap after use.*

Modifications

- Students will be able to calculate heat losses in the pipe runs if the activity is repeated close to the boiler or water heater, and the hot water temperature at the classroom tap is compared with the hot water temperature at a tap near the boiler.

- Students may wish to calculate the possible annual savings if hot water runs to laboratories were closed off and heat sources in the laboratory were used for hot water work instead.

Evaluation

- Calculations, technique, etc. should be evaluated using standard laboratory procedures.

Reference

- Standard physics texts and some physical science texts.

ACTIVITY 13

CALCULATING HEAT LOSSES

INTRODUCTION

A new house in Virginia uses 1/6 as much energy as a similar house built nearby. Another house in Massachusetts uses 1/5 as much energy as a similar house in the neighborhood. The difference between energy-saving houses and energy-wasteful houses is determined by heat losses, through ceilings, floors, and walls, around windows and doors.

In this activity you will calculate heat losses in a home. The method can be used to predict heating requirements for a building when no records of past heating requirements are available.

OBJECTIVES

At the completion of this activity you should be able to:

- o use area, degree days, and R-values in determining heat loss.
- o suggest changes in this activity so it fits the variations in your home.
- o determine the heat loss of your home in BTU's per year and convert this value into an equivalent amount of fuel.

SKILLS AND KNOWLEDGE YOU NEED

- Ability to measure to the nearest inch and nearest foot.
- Ability to calculate areas of rectangular shapes.
- Ability to read data from charts and maps.
- Ability to use a calculator.

EQUIPMENT

- Measuring tape.
- Activity forms.
- Degree-Day Map (attached).
- Pencil and paper.
- Calculator (optional).

METHOD

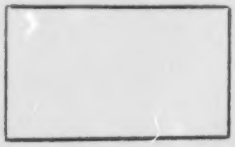
This activity requires care and patience, much like solving a puzzle. Record each answer carefully as you go along; you will need it for your later calculations.

1. Find out the composition of the ceiling and walls of the house you are going to study. What are they made of, what kind of insulation do they have, and how much?

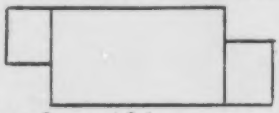
2. Every material retards or slows down the flow of heat energy. How much a material retards the flow of heat is called its R-value. After finding out the composition of your ceiling, use Data Sheet I to calculate the ceiling's R-value. Do the same for the walls on Data Sheet II.

3. Now you must find the area of the ceiling, walls, doors, and windows. This area will show you how much surface the heat is escaping from. All your measurements will be entered on the worksheet for Calculating Area, in square feet.

   A. Ceiling: You can get the total ceiling area by measuring the total floor area. Don't count the garage, the porch, or other unheated areas. If the house is a rectangle, you can just measure length and width and multiply them to get area.



   If the house is a combination of attached sections, you'll have to break the floor plan down into rectangles, find the area of each one, enter each area on the worksheet and then add them up.



   Write your total ceiling area on the worksheet for calculating area, in box A.

   B. Single-pane windows: Measure all the single-pane windows and enter them on the sheet. You may have several of the same size that you can enter on the same line. If you have extra inches, round off to the nearest 1/2 foot. Write your total area for single-pane windows in box B.

   C. Double-pane (storm or thermal pane) windows: Follow the same procedure. Write the total area in box C.

   D. Single outside doors: Same procedure for total area, use box D.

   E. Doors with storm doors: Same procedure; use box E.

   F. Wall area: Measure the perimeter, the total distance around the outside of the house (heated parts only) in feet. Measure the height of the heated portion of the wall. Multiply the two to get the wall area.

Enter on worksheet. Then, on your worksheet, subtract the areas of the windows and doors (boxes B,C,D, and E) from the approximate wall area to get the actual total wall area.

4. Now that you've done all this measuring, you are ready to figure out the average heat loss of this house for a year. To do this you must know R-values and heating-degree-days.

   Take the worksheet labelled "Calculating Heat Loss." Fill in the R-values that you got on your data sheets for the ceiling and walls (I and II). You will notice that the other R-values are given for windows and doors. These are estimates.

5. The degree-days are different in different parts of the country. The teacher should have a map showing the degree-days for your area. (These are given in hundreds, so if the map says 65, you should write 6500 on your worksheet.). The degree days, of course, are the same in each space on your chart.

6. Now copy the area totals from boxes A,B,C,D,E, and F.

7. You've made it this far. You are now ready for the equation that will give you your heat loss.

$$\text{Heat Loss (BTU/year)} = \frac{\text{Area} \times \text{Degree Days} \times 24}{\text{R-value}}$$

$$\text{Example: } \frac{80\text{ft}^2\text{wall} \times 8500\text{DD} \times 24}{\text{R-value of 15}} = 1{,}088{,}000 \text{ BTU/year}$$

   Follow this equation for each line on your "Calculating Heat Loss" worksheet. Add up your heat losses to get the house's average total annual heat loss.

LOOKING BACK

Check all measurements and calculations. Divide the total heat loss in BTU's by 100,000 BTU's. (There are about 138,000 BTU's in one gallon of oil. Since no heating plant is 100% efficient, 100,000 BTU's per gallon represents the useful heat obtained from a very efficient oil furnace; about 72% efficient.). This quotient represents the approximate number of gallons of oil the furnace of this house consumes in a year. Call your oil dealer and check the actual gallons used last year against the computed gallons.

QUESTIONS

1. If the calculated number of gallons of oil and actual gallons of oil used do not agree within 10%, what assumptions can you make about (a) furnace efficiency, (b) the calculated R-values, (c) the measurements and calculations, (d) the oil dealer's records, and (e) this method of calculating heat loss?

2. What are some other reasons which can account for heat losses not taken into consideration in this activity?

3. If the calculated number of gallons is smaller than the actual number of gallons, do you think the answers you gave to #2 can account for the difference?

4. If the calculated number of gallons is larger than the actual number of gallons, what could account for this difference?

5. If your source of heat is not an oil furnace, where could you obtain information to check the accuracy of the computed heat losses in this home?

GOING FURTHER

- Undoubtedly your home does not fit exactly into this structured activity. Using this activity as a model and other resources develop a program which will fit your home.

- Assume that your house's walls have an R-value of 20 and the ceiling an R-value of 30 if they do not already have these values. Then calculate the heat loss with these recommended R-values.

- Using the difference between the two calculated heat losses, calculate the yearly savings.

- Contact a local contractor to give you an estimate of what it would cost to have your home insulated to the R-values recommended in #2.

- Using the yearly savings calculated in #3, how many years will it take to pay for the insulation?

DATA SHEET I

Calculating total R-Value of Ceiling

In the blanks at the right copy the R-Values of those materials which make up the ceiling below your attic.

Interior surface resistance (every ceiling has this)	.68	_____
3/8" sheet rock (gypsum wallboard)	.32	_____
1/2" sheet rock	.42	_____
Air space	.91	_____
3/4" subflooring	1.00	_____
Hardwood floor	.71	_____
3/8" lath and plaster	.42	_____
1/2" ceiling tile	1.40	_____
Glass fiber batts	2.85 per inch	_____
Rock wool batts	3.66 per inch	_____
Glass fiber, loose fill (poured in)	2.20 per inch	_____
Rock wool, loose fill	2.75 per inch	_____
Cellulose fiber (ground paper)	3.66 per inch	_____

I. TOTAL R-VALUE OF CEILING _____

DATA SHEET II

Calculating total R-Value of walls

In the blanks at the right copy the R-Value of only those materials which make up the walls in your home.

Interior surface resistance (every wall has this)	.68	_____
Exterior surface resistance (every wall has this)	.17	_____
3/8" sheet rock	.32	_____
1/2" sheet rock	.42	_____
air space	.91	_____
3/4" fiber board	2.10	_____
3/4" lumber	1.00	_____
1/2" plywood	.63	_____
5/8" plywood	.79	_____
3/8" lath and plaster	.42	_____
1/4" panel	.31	_____
wood siding (bevel lap or shingles)	.81	_____
vinyl siding with 3/8" backer board	.65	_____
aluminum siding with 3/8" backer board	.62	_____
glass fiber blanket	2.85 /inch	_____
rock wool blanket	3.66 /inch	_____
glass fiber (blown in)	2.20 /inch	_____
rock wool (blown in)	2.75 /inch	_____
cellulose fiber (blown in)	3.66 /inch	_____
foam (blown in)	3.66 /inch	_____

II. TOTAL R-VALUE OF WALL = _____

CALCULATING AREA

	NUMBER WITH SAME DIMENSTIONS	x	LENGTH (FT)	x	WIDTH (FT)	=	AREA (FT^2)
CEILING							
			A. TOTAL CEILING AREA			=	
SINGLE-PANE WINDOWS							
	B. TOTAL SINGLE WINDOW AREA					=	
DOUBLE-PANE WINDOWS							
	C. TOTAL DOUBLE WINDOW AREA					=	
SINGLE DOORS							
	D. TOTAL SINGLE DOOR AREA					=	
DOORS WITH STORM DOORS							
	E. TOTAL DOUBLE DOOR AREA					=	
APPROXIMATE WALL AREA	PERIMETER (FT)		X HEIGHT (FT)			=	AREA (FT^2)
	MINUS SINGLE WINDOW AREA (B)						
	MINUS DOUBLE WINDOW AREA (C)						
	MINUS SINGLE DOOR AREA (D)						
	MINUS DOUBLE DOOR AREA (E)						
	F. ACTUAL TOTAL WALL AREA (FT^2)					=	

CALCULATING HEAT LOSS

	AREA	X DEGREE DAYS	X 24 HRS	÷ R-VALUE	= HEAT LOSS (BTU)
CEILING	A.		24	I.	
SINGLE-PANE WINDOWS	B.		24	1	
DOUBLE-PANE WINDOWS	C.		24	2	
SINGLE DOORS	D.		24	2	
DOUBLE DOORS	E.		24	3	
WALLS	F.		24	II.	
	TOTAL HEAT LOSS OF HOME (BTU)			=	

Teacher Information Sheet

CALCULATING HEAT LOSSES

Suggested Grade Level and Discipline

10-12 Science
Regents Physics
General Physics
Applied Physics
Physical Science
Industrial Arts

Background Information

The resistance of a material to heat transmission is known as its thermal resistance or R-value. The total R-value for a structure is found by adding the R-values of the individual materials composing the structure.

The reciprocal of the R-value is U. ($U = 1/R$). U is the coefficient of Heat Transmission, the amount of heat transferred in one hour through one square foot of building structure for each degree Fahrenheit of temperature difference between the inside and outside of the structure.

$$U = \text{BTU's (hr) } (ft^2) \ (^\circ F)$$

BTU is the abbreviation for British Thermal Unit. A BTU is the quantity of heat required to raise the temperature of 1 pound of water 1°F at normal atmospheric pressure.

To caluclate heat loss of a structure per hour °F, multiply U x area.

Heat loss = U x area of structure

This is calculated separately for windows, doors, walls, and ceilings.

To calculate heat loss per day, the heat loss per hour °F is multiplied by 24 hours per day.

Heat loss/day = U x area x 24 hrs.

Heat loss per year is calculated by multiplying by the number of Heating Degree Days in a year. A Heating Degree Day is the mean number of degrees below 65°F for a given day. This implies that heat is only required for a house when the outside temperature falls below 65°F.

$$HDD = 65^\circ F - \frac{(\text{high temp} - \text{low temp for a given day})}{2}$$

Heating Degree Days can then be used as an index to the amount of fuel required to maintain indoor temperatures at 65°F. Seasonal Heating Degree Day Normals (in hundreds) are given on the map on page 13-14.

NOTE: As mentioned on the map, HDD's shown must be multiplied by 100.

Heat loss/year = U x area x 24hrs. x HDD per year

if $U = 1/R$

then: Heat loss/year = $\frac{\text{area x 24 hrs. x HDD/year}}{R}$

Hints on Gathering Materials

- If a 50 foot tape is not available, use a firm string having low elasticity to determine the perimeter of the house. Have several students hold the string against the house so that it follows the contour of the perimeter. Two large nails can be stuck in the ground ten feet apart and the string wound around these to determine the length which is cut off equal in length to the perimeter.

- If the wall is too high to measure, count the number of pieces of siding and multiply by the width of one lay. (Measure several lays and take an average to get the width of one lay.)

Suggested Time Allotment

- One class period for measuring and recording data.

- One class period for making calculations and discussing results.

- One class period for follow-up after students return their completed forms for other selected wood frame dwelling.

Suggested Approach

- Spend a class before the activity explaining the concepts of the BTU, the Heating Degree Day, and R-value, if the students are not familiar with these.

- Have a parent volunteer to have his or her wood frame house measured by the class during a class period. (This assumes such a parent and house are close to the school.) Students will make arrangements with a friend, if their home is not a wood frame building, in order to complete their follow-up assignment.

Typical Results

- A two story wood frame house was measured and calculations made. The outside dimensions of the house were 37 x 37 x 20. The R-Value of the ceiling was 22 and the R-Value of the walls was 4.3. Storm windows were on all windows. Heat loss: ceiling = 11,591,560 BTU, windows = 41,505,120 BTU, 3 doors = 5,795,780 BTU, walls - 113,110,800 BTU; total heat loss = 172,003,260 BTU. Dividing this by 100,000 BTU per gallon of oil yields 1720 gallons of oil. The actual number of gallons used in 1977 was 1,693. All results were based on 7,790 degree days.

Precautions

- *The day before, brief the volunteer parent as to what is expected of him or her. Determine ceiling and wall structure at this time so the home owner can pass this information on to the class.*

- *Only allow two students in the house with the owner to take window measurements. Keep the others occupied outside holding the string or tape to the contour of the building perimeter.*

- *Do not allow students to climb in order to obtain measurements. Challenge them to find another way.*

Modifications

- Instead of visiting a parent's house to make measurements, slides of all sides of a wood frame dwelling could be made and projected on the classroom walls at 1/10 scale. Slides containing information on the wall and ceiling structure could be drawn.

Evaluation

- At the end of the second class period, teams of students should take blank forms home on a weekend to determine the heat losses of one of the team member's home. Each team should be evaluated according to how well they adapted the classroom activity to their team member's home.

References

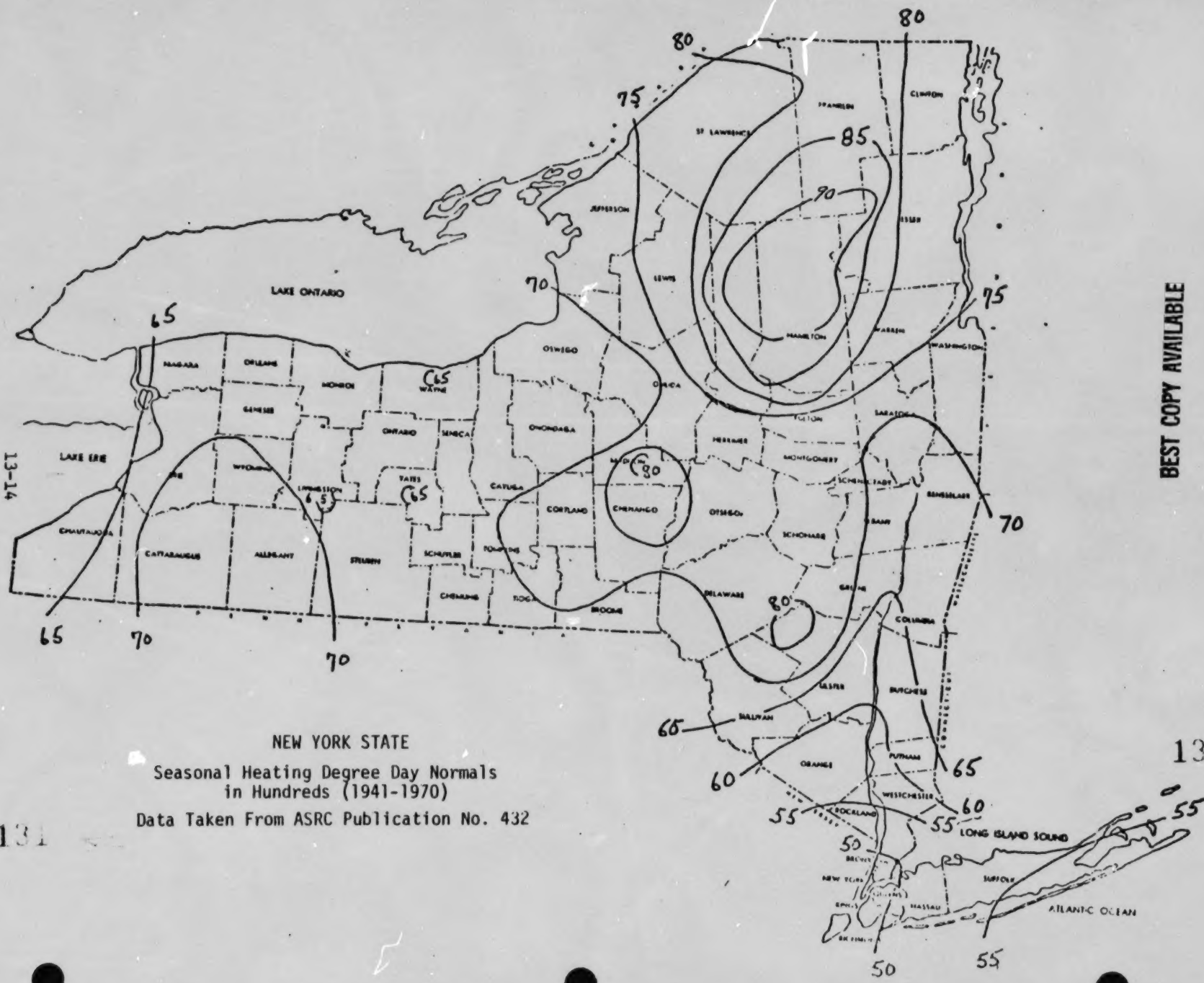
Notes from *"A Conference on Energy Conservation Education"* presented April 23-28, 1978 by the University of the State of New York, NYS Education Department Bureau of Science Education, and the University at Albany Atmospheric Sciences Research Center.

Heating Degree-Days, Atmospheric Sciences Research Center publication No. 432.

In the Bank... or up the Chimney? A Dollars and Cents Guide to Energy - Saving Home Improvements from the United States Department of Housing and Urban Development, Office of Policy Development and Research Washington, DC.

Solar Energy Experiments for High School and College Students, Rodale Press, Emmaus, Pennsylvania.

ASHRAE Guide and Data Book, 345 East 47th Street, New York, New York, 10017. (Source of R-Values)



NEW YORK STATE

Seasonal Heating Degree Day Normals
in Hundreds (1941-1970)

Data Taken From ASRC Publication No. 432

13-14

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BEST COPY AVAILABLE

CONSERVING AUTOMOTIVE FUEL

INTRODUCTION

The United States has only 6% of the world's population, yet it uses 33% of the world's energy. Of that energy, one fourth, a huge amount of fuel, is used for transportation.

How much of your budget, or your family's budget, goes for gasoline? Could some of that be saved?

This activity will show you how you can cut the cost of running a car, and help cut the national oil debt at the same time.

OBJECTIVES

At the completion of this activity you should be able to:

- o compute the annual cost of owning and operating an automobile.
- o complete an energy conservation check on an automobile.
- o practice energy-conserving driving habits.
- o compute cost savings from energy conservation in the automobile.

SKILLS AND KNOWLEDGE YOU NEED

- Basic arithmetic skills.
- Familiarity with auto equipment and instruments.
- Ability to operate an automobile.

MATERIALS

- An automobile.
- A driver's license.
- Records of expenditures for gasoline, accessories, tires, services, insurance, car payments, license and registration, parking, fines and tolls for one year.

METHOD

1. First determine the annual cost of your automobile by completing Data Sheet A: Annual Cost Form, using estimates where bills are not available. Gasoline costs can vary significantly.
2. Use Data Sheet B to keep a Fuel and Mileage Record for two weeks. Determine total fuel costs and miles/gallon for your car during these two weeks.
3. Using Data Sheet C, complete a simple maintenance check of your automobile.
4. Follow the driving check instructions on Data Sheet C. Record fuel and mileage on Data Sheet B for an additional two weeks. Once again determine total fuel costs and miles/gallon for this period.

LOOKING BACK

You have completed an activity that would save thousands of gallons of crude oil per year if generally practiced by all automobile drivers. If you are an average driver and follow the steps in the maintenance and driving checks faithfully, you will probably save ten percent of your fuel costs annually.

QUESTIONS

1. The average annual cost of operating an automobile (gas, insurance, depreciation, finance charges, maintenance, etc.) is now about $3000. (This is for a car that gets about 16 miles per gallon and is driven less than 15,000 miles per year. It does not include car payments.) How does this compare with your estimated annual cost?

2. What will your average annual savings be when driving conservation tips are followed, in gallons of gasoline and in dollars?

3. Assume that the average annual cost of driving for a member of your community is $3,000 per year. What would be the total annual driving cost to your community? How much money could be saved by following the conservation tips?

GOING FURTHER

- Prepare a display that relates annual cost of operation with the make and model of automobile.

- Determine the annual costs of owning and operating other vehicles such as tractors, trucks, and busses. How might their owners reduce costs through maintenance and driving checks?

- Use the Driving Check List on Data Sheet C to prepare a survey of driver behavior. Administer the survey in your school or community. Predict how much fuel could be saved from the data obtained.

DATA SHEET A

ANNUAL COST FORM

1. Original Cost of Car	
2. Depreciation: Multiply step 1 by 25% if the car is new; 10% if the car is more than one year old.	
3. Annual Car Payments: If you paid cash, divide the original cost by the presumed life of the car in years.	
4. Add License and Registration Fees	
5. Add Insurance Costs (annual)	
A. TOTAL FIXED ANNUAL COST (add #s 2,3,4, and 5)	
6. Gasoline Costs Per Year: Weekly cost x 52 or monthly cost x 12.	
7 Service Costs Per Year:	
Oil (oil changes plus extra additions)	
Lubrication (annual costs)	
Tune up (include plugs, points, carburetor adjustments, air filters, etc., annual)	
8. Accessories (mirrors, tape decks, fixtures)	
9. Parking, Fines, and Tolls	
10. Tires	
11. Miscellaneous (unforeseen repairs)	
B. TOTAL OPERATIONAL AND MAINTENANCE COST (add # 6 through 11)	
C. TOTAL YEARLY COST (A + B)	

DATA SHEET B

FUEL AND MILEAGE RECORD

	DATE	ODOMETER READING (FULL TANK)	MILEAGE	#GALLONS	COST	MILES/ GALLON
WEEKS ONE AND TWO						
WEEKS THREE AND FOUR						

DATA SHEET C

MAINTENANCE CHECK

____ 1. Tires inflated to recommended pressure

____ 2. Tires aligned (no wear spots).

____ 3. Air filter clean.

____ 4. Carburetor mixture set for low speed idle.

____ 5. Spark plugs clean.

____ 6. Ignition leads not cracked.

____ 7. Timing accurate: (Car does not hesitate when accelerating and does not continue to "sputter" when ignition is shut off after running for 15 minutes or more.)

____ 8. Extra weight removed from storage compartments. (Store things somewhere else, not in trunk.)

DRIVING CHECK

1. Half minute warm up (no longer).
2. Slow start. (Do not pump. No jack rabbit starts.)
3. Slow acceleration. (Accelerate as gradually as possible for road conditions. Go slowly with a cold engine.)
4. High gear. (Use highest gear possible.)
5. Speed limit. (Try 45 - 55 mph)
6. Allow slowing on hills. (Don't press accelerator unless road conditions require it.)
7. Gentle action on the accelerator. (Think of an orange between your foot and the gas pedal.)
8. Air conditioning off. (Use fresh air from the vents.)

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Teacher Information Sheet

CONSERVING AUTOMOTIVE FUEL

Suggested Grade Level and Discipline

10-12 Multidisciplinary
Students of driving age who own and drive automobiles.

Background Information

Many students understand the concepts and laws that are the basis for the operation of the internal combustion engine and the automobile in general. Applying the law of conservation of energy, reducing friction, fostering complete combustion, and increasing rates of reaction will be new and worthwhile experiences. This activity has been designed to be performed outside of class time, although motivation for a long term activity of this type will probably require class discussion and credit for the work.

Hints on Gathering Materials

- Request that students begin saving their bills and expense records.
- Using an automobile to demonstrate the maintenance and operating checks will help the uninitiated.

Suggested Time Allotment

- Allow four weeks of outside class time with check points and reminders taking place in class.
- Allow a class period for discussion of results.

Suggested Approach

- Assign as a credit project for outside of class.
- Monitor progress, remind students who participate, and "call in" data sheets periodically for examination.

Typical Results

- Results will depend on type and condition of the auto and the effects of peer pressure on those carrying out the activity.

Precautions

- *Contact parents in advance concerning the nature of the project, and seek their cooperation.*
- *Recommend that students observe standard safety measures as they complete the maintenance check. Professional services should be sought when necessary.*

Modifications

- Ask half of your students to disregard the maintenance check of Data Sheet C before changing their driving habits. To what extent does poor maintenance limit fuel and cost savings?
- Modify Data Sheets A, B, and C to correspond to an analysis of fuel costs and savings in vehicles other than automobiles, e.g., trucks, busses, etc.

Evaluation

- At the project's conclusion, collect the Data Sheets and check for feasibility, completeness, and accuracy of calculations.
- During the follow-up discussion, look for evidence of student attitude changes.

References

EPA/FEA Gas Mileage Guide, Fuel Economy, Pueblo, Colorado, 81009

Energy Conservation in Transportation, The United States Department of Transportation, Washington, D.C. 20590

ACTIVITY 15

ENERGY IN FOODS

INTRODUCTION

Your body gets its energy from the food you eat. You use this energy to work, to play, and to keep warm. So food is actually a fuel, but most of us don't think of it as fuel just like a gallon of gasoline or a pound of coal.

In this activity you will see that food contains energy that you can measure.

OBJECTIVES

At the completion of the exercise you should be able to:

- o Understand that foods, in this case nuts, contain energy.
- o Understand how the energy content of a food can be measured.
- o Be able to determine the energy given off by each of a number of different types of nuts.

SKILLS AND KNOWLEDGE YOU NEED

- Weighing objects on a balance.
- Measuring volume of water with a graduate cylinder or measuring cup.
- Skills with using open flames (to be determined by your teacher).
- Using a thermometer to record temperatures.

MATERIALS

- Celsius thermometer.
- Large cork.
- Straight pin.
- Small tin can (8 oz. soup can). or 150 ml. beaker.
- Aluminum foil.
- Matches.
- Nuts (e.g. peanut, walnut, pecan, almond, etc.)
- Ring stand with ring and wire gauze (Diagram #1) or heating stand (Diagram #2).
- Balance to weigh nuts.
- Graduated cylinder or measuring cup.
- Goggles.

Diagram 1
Ringstand

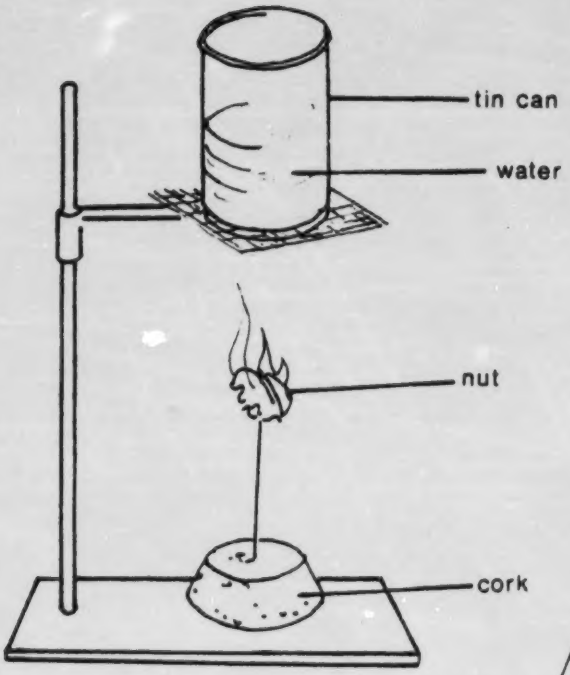
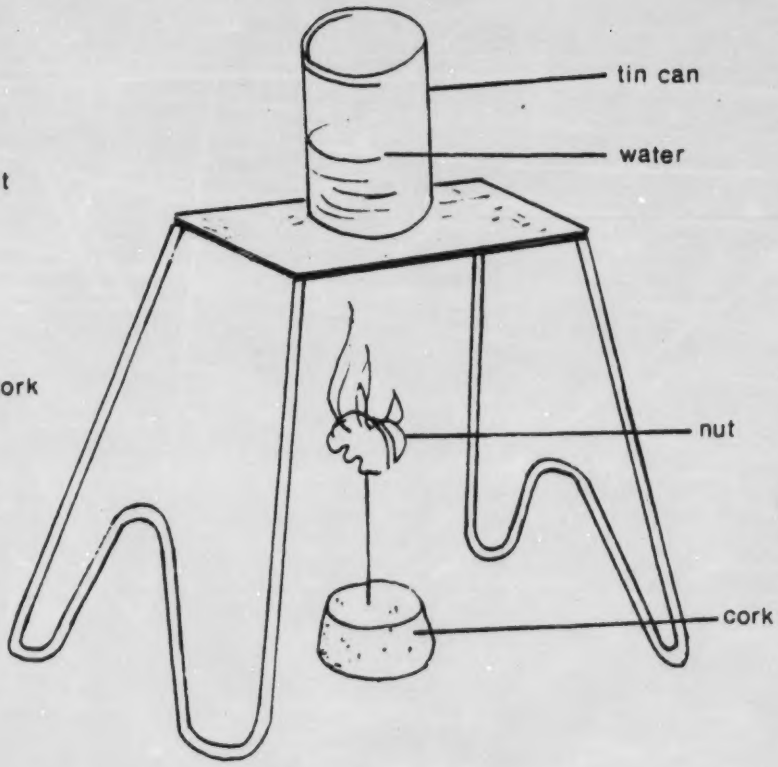


Diagram 2
Heating Stand



METHOD

1. Set up your materials as pictured in the diagram.
2. Cover the cork with aluminum foil and insert the pin in the cork as shown in the diagram.
3. Try to use about the same size nut in each trial. Weigh a nut on the balance, and record your answer in grams in column 1 on Data Sheet A. Then place the nut on the end of the straight pin and position it about 2.5 centimeters below the can.

4. Measure out 100 ml. of water. Pour the water into the tin can and place in position as shown in the diagram. Always start with fresh cold water from the tap. Put the thermometer in the water before heating and record the temperature in column 2. (Do not allow the thermometer to touch the bottom.)

5. With the nut in place under the can, set fire to the nut and allow it to burn completely. If it goes out, light it again until the nut will not burn any longer.

6. Observe the temperature rise during heating. Record the highest temperature reached after the nut has completely burned. Record this in column 3.

7. Subtract the beginning temperature from the final temperature and enter the change in temperature for each trial in column 4.

8. Do one more trial for this same kind of nut.

9. Add the change in temperature for each trial and divide by 2 (the number of trials). Record this in column 5.

10. Add the masses of the nuts for each trial and divide by 2 (the number of trials). Record this in column 6.

11. Divide the number in column 5 by the number in column 6. Your answer gives you the average temperature change for each gram of nut you burned. Record this in column 7.

12. Now repeat the procedure for each different kind of nut you are testing.

LOOKING BACK

The amount of energy in different foods is variable. Even nuts have different food values. Some nuts would be most appropriate for high energy foods while hiking, while others would be a better choice for people who want to munch but who have no plans to use the fuel in working or playing.

QUESTIONS

1. Which kind of nut caused the greatest temperature change per gram?

2. Which kind of nut caused the smallest temperature change per gram?

3. Which nut gave off the most energy?

4. Which nut gave off the least energy?

5. What evidence have you discovered that shows food has energy?

6. Where else did the heat energy from the nut go other than into the water?

GOING FURTHER

You can determine the number of calories of heat gained by the water . Use Data Sheet B to record your information. Weigh the empty can, then the can with the water in it. Subtract to get the mass of the water only. Use the following formula to determine the number of calories gained by the water.

Heat in calories = Mass (weight) x Specific Heat of Water x Change in Temperature

Heat = (10 grams) x (1c/gram/^{o}C) x (2^{o}C) (Example)

Heat = 20 c.

Is this the same as the number of calories released by the nut? Why or why not?

Many energy sources are used in the production of foods. List the possible energy sources that are used, starting from the planting of a peanut seed to the eating of the final product at home. Be sure to include those energy sources used on the farm, in the processing, transportation, packaging and preparation at home.

DATA SHEET A

TYPE OF NUT	TRIAL	COLUMN 1 Mass of Nut (grams)	COLUMN 2 Beginning temp. of H_2O	COLUMN 3 Final temp. of H_2O	COLUMN 4 Change in temp.	COLUMN 5 Average Change in Temp.	COLUMN 6 Average mass	COLUMN 7 Average temp. change per gram
	1							
	2							
	1							
	2							
	1							
	2							
	1							
	2							
	1							
	2							

15-6

DATA SHEET B

(GOING FURTHER)

TYPE OF NUT	MASS OF H_2O	CHANGE IN TEMPERATURE	CALORIES GAINED

Teacher Information Sheet

ENERGY IN FOODS

Suggested Grade Level and Discipline

6-8 General Science
Life Science

Background Information

Energy conservation can be personalized in the area of food consumption. Calories of energy available from various foods are listed in diet and nutrition publications. Nuts are an energy source sometimes used to illustrate calories available from foods in science classes where some approximate analysis is sufficient and where comparative data makes a point -- food value for energy is variable. One must be aware of food value when considering energy available for doing work.

The calories calculated in the "Going Further" section are scientific calories (c). Each food calorie equals 1,000 of these calories. A food calorie is a kilocalorie (C).

Encourage students to consider the energy investment in modern agriculture. The calories of energy invested in bringing food to the consumer are considerable. Some sources have claimed that as many as 8 calories are invested in each calorie produced for the American consumer.

Hints on Gathering Materials

- The materials can be simple or complex as described in the activity.
- Be sure that goggles are available and used by students.

Suggested Time Allotment

- One class period to introduce topic, demonstrate equipment and form groups unless students are familiar with this type of activity.
- One class period to perform the activity, make calculations, and discuss.

Suggested Approach

- Set up the materials or collect from storage for distribution ahead of class time. Open nuts ahead of time. Divide students into equal groups. Have a member of each group record data, another read the thermometer, and a third member ignite the nuts.

Typical Results

- Depending on the nuts used, the data will vary as much as a factor of 10 from one kind of nut to another.
- The results should be generally consistent among the class for high energy nuts. Low energy nuts may not supply sufficient energy to raise the water temperature.
- Most of the heat energy from the burning nut heats the surrounding air. Very little actually heats the water in the can.

Precautions

- *Use goggles.*
- *Do not have students do this exercise unless they are used to working with open flames, and have developed the necessary skills.*
- *Do a demonstration with students taking data, if student skills are below what is required.*

Modifications

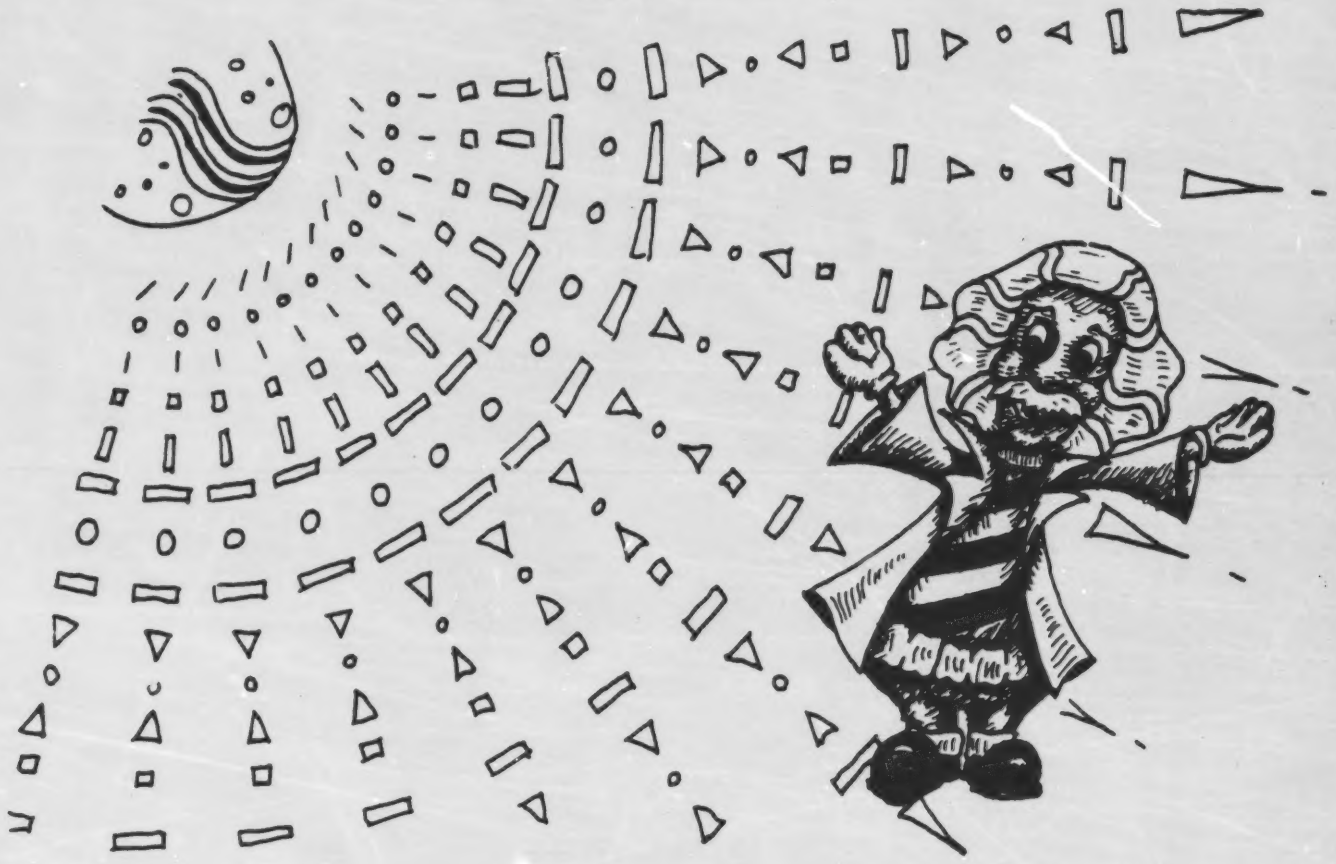
- Use fewer nuts. Try different amounts of water. Try different foods. Investigate the use of a "bomb calorimeter" which may be available from the secondary school or nearby college. Bomb calorimeters use an electrical cord in an enclosed container for this type of work. Have students design a better container to eliminate some heat loss.

Evaluation

- Evaluate student accuracy in weighing, measuring temperature and in calculations.

ACTIVITY 16

CONSERVING WITH THE SUN



INTRODUCTION

The sun is an energy source which can help to conserve our limited supply of fossil fuels, such as coal, oil, and gas. Some homes and businesses are beginning to rely upon solar energy for both space and water heating. Many buildings are being designed to take advantage of passive solar energy by having their largest windows facing the south so that entering sunlight warms the air inside. Equally important is the advent of an "active" solar technology using collectors, pumps, and storage units. Solar collectors can be mounted on homes to supply both hot air and water, reducing the use of fossil fuels for these purposes.

One factor important to those who intend to install a solar collector system is the changing angle of solar radiation. The amount of solar energy that strikes a surface on earth will vary with the changing seasons and angle of the sun above the horizon. The higher the sun is in the sky, the more concentrated is its radiation upon a section of the earth's surface. When do you think a section of the surface receives the greatest amount of solar energy? This activity will enable you to estimate the concentrations of solar energy at a middle latitude for the first days of summer, fall, winter, and spring.

OBJECTIVES

At the completion of this activity you should be able to:

- o determine the amount of incoming solar energy in calories per square cm. at noon on the first day of any season at the latitude of New York City.
- o describe how the incoming angle of a beam of sunlight affects how much energy is absorbed by a surface.
- o describe the relationship between the angle of solar radiation and the changing seasons.
- o describe the proper orientation of a solar collector panel for maximum efficiency.

SKILLS AND KNOWLEDGE YOU NEED

- How to construct angles using a protractor.
- How to square a number.
- How to multiply and divide with decimals.

MATERIALS

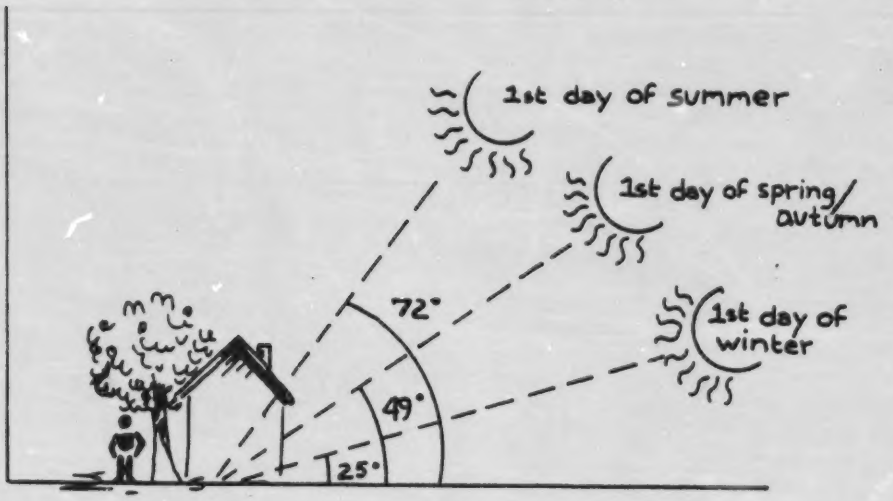
- Metric ruler.
- Protractor.
- Pencil and unlined paper.
- Flashlight with square mask.
- Index card or cardboard.

METHOD: PART A

1. Obtain a flashlight with a square mask from your teacher. Hold the flashlight vertically about 15 cm. above the desk so that the light shines straight down on the paper as a square. Trace the outline of the lighted area.
2. While holding the front of the flashlight, tilt it so the beam strikes the paper at an angle. Trace the outline of the lighted area.
3. Record your observations about the difference in size and shape of the two lighted spots.

PART B

For our calculations, we will use the middle latitude location of New York City, latitude 41°. The diagram below illustrates the seasonal variation in sun angle at noon.



The intensity of the sunlight which reaches the top of the earth's atmosphere has been measured at 1.94 langleys/min (1.94 calories/cm^2/min). Some of this energy is either re-radiated back into space or absorbed by the atmosphere, reducing the intensity of the sunlight reaching the earth's surface.

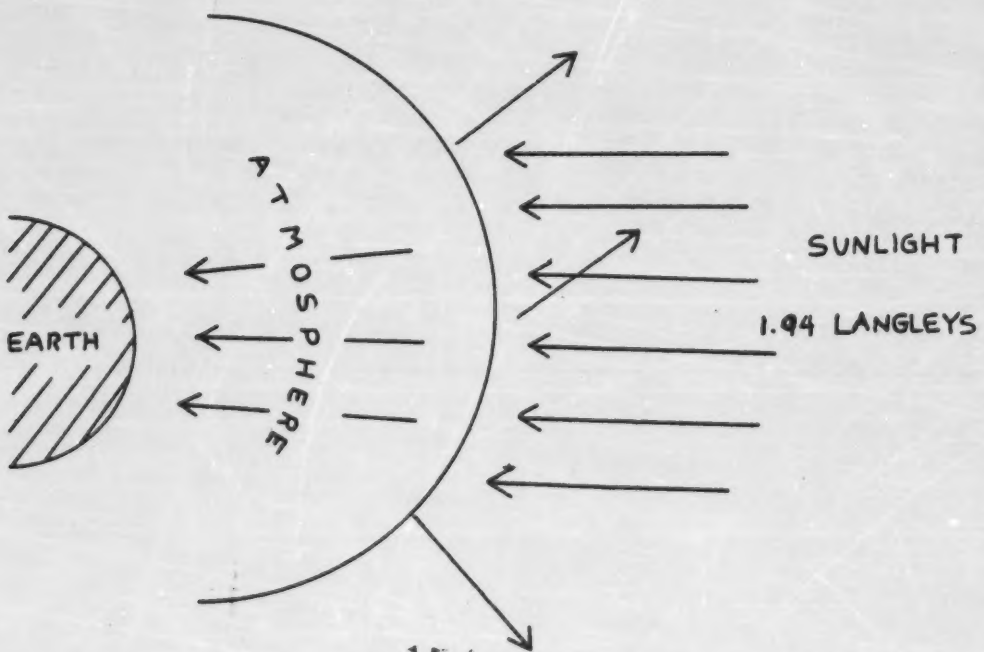


DIAGRAM A

Index Card

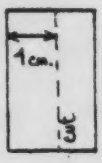


DIAGRAM B

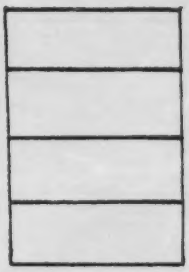


DIAGRAM C

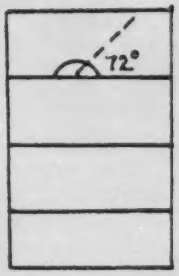
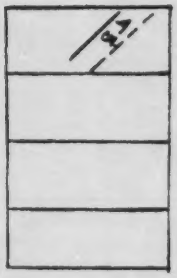


DIAGRAM D



For this activity we will use a value of 1.00 langleys/ min (1.00 calories/cm^2/min) as the intensity of sunlight near the earth's surface.

1. Mark off a 4 cm. wide strip on a piece of cardboard or index card and cut it off. (Diagram A)

2. On a separate sheet of unlined paper, draw three horizontal lines with a ruler: the first should be one-quarter of the way down the sheet, the second half-way, and the third three-quarters. (Diagram B)

3. With a protractor, draw a line which will meet the first line on your paper at an angle of 72° (see Diagram C). Now place your cardboard strip along this angle and draw a parallel line 4 cm. from it along the other edge of the strip (see Diagram D). This pair of lines represents a beam of sunlight striking the earth's surface on the first day of summer.

4. If we assume this beam is square, like the flashlight beam, its cross-sectional area is 4 cm. squared or 16 cm^2.

5. The energy of sunlight near earth has a value equal to 1.00 calories/ sq.cm./min (or 1.00 langleys/ min). Multiply this solar constant times 16 sq.cm., the size of the light beam. (See next page).

1.00 calories/cm^2/min x 16 cm^2 = _____calories/min

This is the total energy the beam of sunlight carries per minute.

6. Extend the parallel lines (your "sunbeam") until they intersect the first horizontal line. Measure the distance between the points of intersection. It should be MORE THAN 4 cm.

The distance equals _____ cm.

Multiply this distance by 4 cm. (the width of the beam) to find the area covered by the beam of sunlight.

Area = _____ cm^2.

7. You now know the total energy of your sunbeam (step 5) and the total surface area covered by your sunbeam (step 6). If you divide these two numbers you will get energy per unit area.

$$\frac{\text{Total energy}}{\text{Total area}} = \frac{\text{_____ cal/min}}{\text{cm}^2} = \text{_____ cal/min/cm}^2.$$

This is your summer value of solar intensity.

8. On the second horizontal line, use your protractor to draw an incoming line at an angle of 49^o. This represents the sun's angle at spring or autumn. Next, draw a parallel line exactly four centimeters away. Repeat steps 6 and 7 (total energy is the same, but total area covered will be different).

$$\frac{\text{Total energy}}{\text{Total area}} = \frac{\text{_____ cal/min}}{\text{cm}^2} = \text{_____cal/min/cm}^2.$$

This is your spring or fall value of solar intensity.

9. On the third horizontal line, use your protractor to draw an incoming line at an angle of 25^o. This represents the sun's angle in winter. Next, draw a parallel line exactly four centimeters away. Repeat steps 6 and 7 and obtain the energy per unit area.

$$\frac{\text{Total energy}}{\text{Total area}} = \frac{\text{_____ cal/min}}{\text{cm}^2} = \text{_____cal/min/cm}^2.$$

This is your winter value of solar intensity.

LOOKING BACK

We have assumed that the amount of energy reaching the earth is the same for each "sunbeam." The surface area covered by a sunbeam differs from season to season. It is similar to sharing a gallon of ice cream with six, nine, or twelve people. Naturally, six people would each have a larger share than nine or twelve. When the sun is nearer to the horizon, its energy is "shared" or spread over more surface area and each unit of area receives less radiation. The reverse situation is true in summer.

QUESTIONS

1. How much solar radiation strikes one square centimeter of sidewalk in New York City at noon on June 21st? September 23rd? December 21st? March 21st?

2. Are seasonal variations in solar intensity due more to differences in solar energy carried by the beam or to differences in the surface area the beam of light falls upon?

3. Describe the relationship between the incoming angle of a beam of sunlight and the surface area it covers.

4. How is the incoming angle of a beam of sunlight related to the seasons of the year?

5. How is the surface area the beam falls upon related to the seasons of the year?

6. After completing this activity, how would you orient a solar collector panel to maximize its efficiency? Explain your answer.

7. What other factors besides the incoming angle affect the total energy a surface receives?

GOING FURTHER

- Base your calculations on your own latitude. You will have to determine the proper angles to use.

- Try using polar latitude and/or a tropical latitude in your calculations. Why do these regions have much less seasonal variation?

- What is the significance of the Tropic of Cancer and Tropic of Capricorn to incoming solar radiation?

Teacher Information Sheet

CONSERVING WITH THE SUN

Suggested Grade Level and Discipline

7-9 Science
Physical Science
Earth Science
General Science
Mathematics

Background Information

A question some people ask is, "If we are closer to the sun during the winter, then why aren't we warmer? The answer is that the three million mile difference causes a slight increase in temperature, but not much. More important is the fact that during the winter, due to the inclination of the earth's axis, the sun does not rise as high above the horizon in the northern hemisphere. As a result, the sun's radiant energy strikes this part of the earth at a very acute angle. This spreads the energy out over a larger area. Each square unit of the earth's surface consequently receives a smaller fraction of the total energy.

Hints on Gathering Materials

- Before the exercise, obtain information on solar angles at various latitudes.
- Have sample solar beam constructions available for student comparison during the discussion period.
- Prepare square masks and tape them over the lenses of the flashlights.

Suggested Time Allotment

- One period to complete the procedures (finishing calculations for homework is a possibility).
- One period to correct and discuss results in terms of the questions.

Suggested Approach

- Introduce energy terms (calories, langleys) and concepts before this exercise.
- Have students work in small groups.
- Check calculations periodically as group work proceeds.

Typical Results

- Line 1, first day of summer at noon: distance between the points of intersection = 4.3cm.
- Line 2, first day of spring and fall at noon: 5.5cm.
- Line 3, first day of winter at noon: 9.8cm.

Precautions

- *None*

Modifications

- Instead of cm^2 and calories, use ft^2 and BTU's; 1.00 calories/cm^2 = 3.69 BTU's/ft^2.

Evaluation

- Observe student's ability to follow instructions.
- Review constructions during class for neatness and accuracy.
- Collect and review calculations. Are they accurate?
- Collect and review questions. Are the answers logical and well thought out?

References

Solar Energy, William W. Eaton, Department of Energy, Office of Public Affairs, Washington, DC 20585

Solar Dwelling Design Concepts, US Department of Housing and Urban Development. Supt. of Documents, US Government Printing Office, Washington, DC 20402

Solar Energy and Your Home, US Department of Housing and Urban Development, National Solar Heating and Cooling Information Center, PO Box 1607, Rockville, Maryland 20850

ACTIVITY 17

COMPARING FUEL SOURCES

INTRODUCTION

In providing homes with a supply of hot water, people often have a choice of several different heat sources. Which sources are commonly available in your area? Which one do you think makes the best use of the fuel consumed? This activity involves heating water by two methods: (1) directly, by burning fuel in a camp stove; (2) indirectly, by using fuel to generate electricity which in turn will be used to heat the water. Which method do you think shows the wisest and best use of energy?

OBJECTIVES

At the completion of this activity you should be able to:

- o compare two heating methods and the energy they require.
- o identify ways in which heat or energy is lost.
- o suggest ways to conserve energy resources by matching the energy use to the most appropriate energy source.

SKILLS AND KNOWLEDGE YOU NEED

- How to safely handle combustible materials.
- How to safely handle hot equipment.
- How to operate a gasoline-powered generator and camp-type stove.

MATERIALS

- Camp-type gasoline stove.
- 2 equal size water containers (#10 cans or kitchen pots).
- Electric hot plate.
- 110-volt gasoline-powered generator.
- 1/4 pint of gasoline
- 1/4 pint of camp-stove fuel

METHOD

1. Connect the electric hot plate to the 110-volt generator. Fuel the generator with 1/4 pint of gasoline.
2. Add an <u>equal</u> amount of camp-stove fuel to the camp stove.
3. Fill the 2 containers with equal amounts of tap water.
4. Begin heating the water using one container for each heat source.
5. When a container boils, empty it, refill it with the same amount of water and continue heating.

6. Record the number of containers boiled by each method.

Camp Stove	Generator/Hot Plate	
_____	_____	# containers boiled
_____	_____	quantity of water boiled in each container

7. Continue until both systems run out of fuel.

LOOKING BACK

When some people think of conservation, they picture self-denial and sacrifice. Conservation can be achieved by careful matching of the appropriate energy source to the task. Such measures can save valuable energy.

QUESTIONS

1. How much water was boiled by the camp stove? By the hot plate?
2. Based on your data, which system used its fuel more efficiently?
3. How is heat lost from the generator/hot plate system?
4. How would your results have been affected if there were long wires between the generator and the hot plate?
5. How is heat lost from the camp stove?
6. What could be done to reduce that heat loss?

GOING FURTHER

- Investigate the types of fuels used by public utility generating systems. What are some other uses for these fuels?
- Read about the problems of heat pollution associated with generating plants.
- Compare the efficiency of a variety of home heating systems (electric baseboard, oil/hot water, etc.). Which do you think is best? Why?

Teacher Information Sheet

COMPARING FUEL SOURCES

Suggested Grade Level and Discipline

7-12 Physical Science
Ecology
Physics

Background Information

The conservation of petroleum resources is a topic about which much has been and will be written. Petroleum and its many products are indeed an integral part of our society. It is fitting, therefore, that our society be aware of how it is "spending" this precious resource. Conservation can be achieved through wise use as well as through decreased use.

When introducing and summarizing this activity, be sure that students are aware that they are only qualitatively comparing the two methods. Since the fuels used (gasoline vs. "white gas" or kerosene) are not the same, one cannot make a truly quantitative comparison. Bring out the fact that fossil fuels are usually used to generate electricity and losses in energy occur at the power plant and in the transmission lines between source and consumer.

Quantitative comparisons can be made if students are given the following information on heat equivalents:

Gasoline = 125,071 BTU's/gallon
Kerosene = 135,000 BTU's/gallon

Hints on Gathering Materials

- The school maintenance or transportation department may supply a generator.
- Collect containers for several days before exercise.
- See Precautions.

Suggested Time Allotment

- One class/lab period.

Suggested Approach

- See Precautions.
- Assign questions as homework.

Typical Results

- Camp stoves will probably heat more water.

Precautions

- *Before activity, store fuels in proper containers.*
- *Wear safety goggles.*
- *Operate generator and stove in a properly ventilated area.*
- *Have "hot pads" available for handling water containers.*
- *After activity, place hot containers, etc. out of the way to cool off.*
- *Properly dispose of any leftover fuel. (Do not store in the classroom.)*

Modifications

- This exercise may be done as a demonstration.
- If used with a physics class, the teacher may want to stress the aspect of heat loss and its relationship to the laws of thermodynamics.
- Have students consider energy losses in transmission lines.

Evaluations

- Observe students' safety habits.
- Collect and review students' answers to the Questions section. Are the answers properly based on available data? Are conclusions logical and reasonable?

References

An Educator's Introduction to Energy Concepts, Maine Audubon Society, 118 Old U.S. Rt. 1, Falmouth, Maine 04105.

ACTIVITY 18

ENERGY IN PRINT

INTRODUCTION

Whether we know it or not, we are all making decisions every day about energy. We make decisions about energy when we use lights or hot water. We make decisions about energy when we buy a car or when we vote.

Your personal decisions will be better if they are based on accurate and current information. The facts which you obtain through the research in this activity will help you to make informed decisions for your energy future.

OBJECTIVES

At the completion of this activity you should be able to:

- o list available sources of information about energy conservation.
- o cite information related to a specific topic or question about energy.

METHOD

1. Using the index system in your library, look up three sources of information on energy and enter the title and location (book number) on Worksheet A.
2. Using the Reader's Guide to Periodical Literature, research three articles relating to energy and enter the title of the article, name of the publication, and the date of the publication on Worksheet A.
3. Go through some recent newspapers. List three newspaper articles relating to energy on Worksheet A.
4. Obtain three energy-related brochure pamphlets. Try some of the following sources: local, county or state government agencies; utility companies; business agencies; or public service organizations.
5. Answer the following:
   - You want to insulate your attic. Find the information that details the amount needed, the steps to be followed in installing, and the different types available.
   - Find the location of the major coal deposits in the United States.
   - Find the names and addresses of three local insulation contractors.
   - Explain the differences between lignite and anthracite coal.
   - Explain the arguments for and against nuclear energy generation.

LOOKING BACK

The information you and others need in order to make informed decisions about energy is available. Some kinds of information are needed for personal projects while other kinds of information are needed for participation in decisions society must make. Your ability to find and use this information is important to all of us.

QUESTIONS

1. Where will one find the best information on energy projects to be completed around the home?

2. What are the best sources of information about social issues like nuclear power generation?

GOING FURTHER

- Arrange a debate on current energy issues, such as tax rebates for conservation, the nuclear power problems, deregulation of gasoline prices, the best energy policies for the present and the future, etc. Require that each debater present facts to back up his opinions, and tell where he got his information.

WORKSHEET A

I. INDEX SYSTEM

	Title	Author	Library Location (bk. #)
1.			
2.			
3.			

II. READER'S GUIDE TO PERIODICAL LITERATURE

	Title	Publication	Date
1.			
2.			
3.			

III. NEWSPAPER ARTICLE

	Title	Newspaper	Date (page)
1.			
2.			
3.			

IV. BROCHURE

	Title	Source
1.		
2.		
3.		

V. ANSWERING QUESTIONS

1. Insulating your attic. (Source of information).

2. The location of major coal deposits.

3. Three local insulation contractors.

4. The difference between lignite and anthracite.

5. The arguments for and against nuclear energy generatior.

Teacher Information Sheet

ENERGY IN PRINT

Suggested Grade Level and Discipline

7-12 Science
Language Arts

Background Information

This activity directs students to a number of potential sources of information about energy. The quality of decisions and the activities that result from these decisions will depend upon the quality of the sources. The energy enterprise is an active one and facts and figures change. People must be made aware of the sources of information that are useful for a wide variety of actions. Some sources are useful for do-it-yourself projects while others are more appropriate for establishing positions on national and international issues.

Hints on Gathering Materials

- A call to your local town, city or county government and state energy office will probably result in useful publications as sources of information. Plan this activity 3 weeks ahead of class involvement.

- The library staff will often assist by placing often used publications on reserve so that all students will have an equal chance in using limited numbers of important sources. Plan this request ahead of time.

Suggested Time Allotment

- This is a project-type activity and requires approximately 4 hours of out-of-class time for average students, depending upon age and level.

Suggested Approach

- Display your own sources but encourage students to obtain their own information.

- Allow a wide variation in student approach to this activity. Some students will try to see this as a library research activity. It is more than that. Students are directed to use a variety of sources.

- Tie this activity with an activity required for some other subject area and allow for double credit.

- Have students extend this activity into their homes, the public library, etc., through a display of their work.

Typical Results

- Some students have no difficulty with research. Others lack research skills and should be monitored for progress if the project is assigned over a period of time as a home assignment.

Modifications

- This activity lends itself to bulletin board displays, school energy week observances, debate research, energy fair projects, etc.

Evaluation

- Check worksheets for variety. Section V of the worksheets is the most challenging part of the activity and should be evaluated for accuracy. Duplicate answers in this section may be due to either a lack of information available to students or an unwillingness on their part to extend their efforts.